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DISEASES and INSECTS of GARDEN VEGETABLES

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DISEASES AND INSECTS OF GARDEN VEGETABLES

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GENERAL CONTROL MEASURES

FROM THE TIME the seeds of garden plants are put into the ground until the crops are gathered, diseases and insects must be fought. Vegetable troubles are due to numerous causes, including unfavorable soil conditions—too wet or too dry, too rich or too poor, lack of humus or lime—weather unsuited to some crops, careless use of fertilizers, or attacks of fungi or other parasites. The adoption of the best horticultural practice—crop rotation, the careful application of fertilizers suited to each crop, adequate cultivation, the planting of all crops in their proper season—is important for the successful growing of garden crops. The control of diseases caused by fungi, bacteria, and other enemies requires special additional treatment, as does the damage caused by insects. The purpose of this bulletin is to present briefly control measures for the more important insects and fungus and bacterial diseases of home-garden vegetable crops.[2]

The use of disease-free seed and plants is fundamental to all disease control. A modified application of the principle of crop rotation can be made even in the home garden by moving the rows of each vegetable to a different place each year. Many diseases, as well as insects, live over winter in the soil and will appear again the next season if plants of the same kind are grown in the soil. Other diseases pass the winter in perennial host plants in or near the garden and are carried to the garden plants by insects in the spring. Furthermore, since many of the pests of closely related vegetables are the same, such crops should not be planted in succession. A vine crop should not follow any vine crop, nor should crucifers follow one another.

Numerous important diseases, such as bean anthracnose, pea pod spot, and potato leaf roll and mosaic, are carried in or on the seed and cannot be controlled by seed treatment. It is therefore essential to secure the most disease-free seed obtainable.

Some of the worst garden troubles, such as root knot and clubroot, are brought in on the roots of seedling plants and not only damage the present crop but remain in the soil to attack future crops. In buying plants one should be sure they are healthy and free from in-

[1] Died Nov. 17, 1933.

[2] For a more complete discussion of the diseases and insects attacking special crops or for information on the methods of growing garden crops the reader is referred to other publications of the U. S. Department of Agriculture.

sects. The roots should be clean, hairy, and free from knots or swellings. "Prevention is better than cure", especially in the home garden, which usually must be planted on the same ground year after year.

Injurious insects may be divided into two classes with reference to their manner of taking in food. Caterpillars, beetles, grasshoppers, and grubs have biting mouth parts and feed by biting off, chewing up, and swallowing the substance of the plant. On the other hand, the mouth parts of plant lice, thrips, leafhoppers, and plant bugs form a tubular beak through which the juices from within the plant are sucked up and swallowed. On this account the latter are not affected by stomach poisons that may be applied to the surface of the plant, but must be controlled by contact insecticides or remedies that kill by actually touching the insect.

In growing to maturity insects may pass through two different series of changes. Plant lice, thrips, grasshoppers, leafhoppers, and plant bugs are hatched from the egg in a form that resembles that of the full-grown insect, usually, however, without wings, although the adult may be winged. On the other hand, newly hatched beetles, moths, and flies first appear in the forms variously known as grubs, caterpillars, and maggots. After passing a variable time in this stage they enter an inactive period, known as the pupa or chrysalis, and in due time cast off their protective covering to become full-grown beetles, moths, and flies. The gardener should become familiar with the different stages of the destructive pests that, taken together, require almost daily repressive measures during the growing season.

In considering the control of the various plant insects and diseases in the following pages the treatment and prevention of each is discussed. Under the heading "Treatment" are discussed the methods of control that may be applied after the disease or insect has appeared in the garden, such as the use of poisoned bait for cutworms, the hand-picking of insects, burning diseased plants, or spraying for disease and insect control. Under "Prevention" are included all measures of control applied prior to disease or insect appearance that will tend to hinder or stop the development of the disease or insect or prevent overwintering and the attack of the next season's crops, such as planting disease-resistant, disease-free, and weevil-free seed, treatment of seed to kill insects and diseases, or the planting of crops on parts of the garden free from these pests.

GENERAL CROP PESTS

While many plant diseases and insects attack only one crop or a group of related plants, there are some that may attack almost any of the garden vegetables. The most important diseases in this class are damping-off and root knot, and the most important insects are cutworms, aphids or plant lice, leafhoppers, blister beetles, flea beetles, grasshoppers, and wireworms. Red spiders, nematodes, slugs, and snails are also general feeders.

DAMPING-OFF

When seeds of tomato, cabbage, or other vegetables are planted in coldframes or in small boxes in the house to raise early plants for

setting in the garden, a disease called damping-off often causes much trouble. Small plants may suddenly fall over and die, or black dead areas may appear on the stems near the soil, which dwarf or kill the plants (fig. 1). This disease usually attacks seedlings that have been overwatered or have been kept too warm or have not been properly thinned.

FIGURE 1.—Damping-off of tomato seedlings.

Treatment.—Thin the plants where necessary, give them plenty of air and light, and keep the soil fairly dry while the plants are small, watering lightly and only early in the day so the soil will dry quickly.

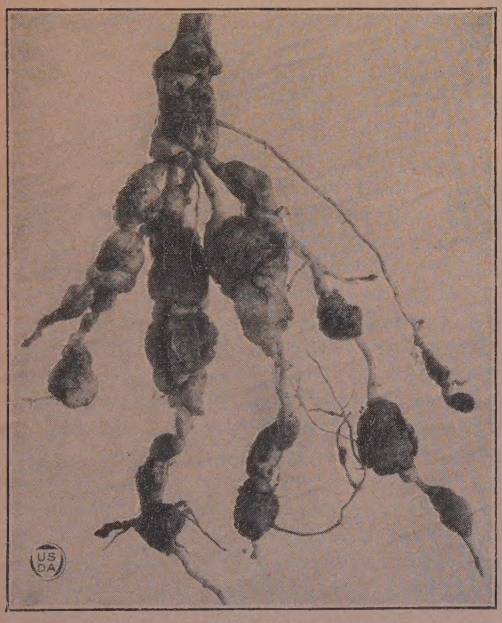

FIGURE 2.—Root knot on tomato. Similar galls occur in infested soil on the roots of many vegetables.

Prevention.—One of the best methods of preventing damping-off and root troubles that may attack small plants is to sterilize the soil in the coldframe or the seed box. Formaldehyde dust or some of the mercuric dusts applied to the seed or mixed with the surface soil have also been used with success to prevent damping-off.[3]

ROOT KNOT

Southern gardens suffer greatly from eelworms or nematodes, which cause irregular swellings or galls on the roots of nearly all vegetables. In fact, root knot is perhaps the most widespread and serious truck-crop disease that occurs in the South, causing severe losses due to the stunting and death of many plants and a reduction of yield in others (fig. 2). It is most troublesome in sandy soils. Do not confuse this with the beneficial nodules on beans and other legumes or with the clubroot of the cabbage family.

[3] Directions for carrying out the different control measures and for preparing the various fungicides referred to in the text are given under the headings Fungicides and Insecticides, and Miscellaneous Control Methods, near the end of the bulletin.

A garden infested with root knot may produce winter crops, as the eelworms are inactive in cold weather, but for summer crops either a new location must be chosen, in which case every precaution should be taken to prevent root knot from getting a foothold in the garden, or a system of rotation should be started to reduce the nematodes. Rotate the susceptible vegetables with corn or other immune crops. Have two or three enclosures, if possible, and alternate garden, chicken yard, and immune crops. The fowls will help the immune crops to starve out the nematodes by keeping the place free from all plant growth and will at the same time enrich the ground. Farmers' Bulletin 1345, Root-Knot: Its Cause and Control, gives more complete information on this disease and should be secured by all who know of its occurrence in their garden or fields.

CUTWORMS

The smooth gray and brown cutworms (fig. 3) hatch from eggs laid in late summer by obscure brownish moths. They reach considerable size before the winter, which they pass as caterpillars, often appearing in great numbers in early spring and summer, hungry from their long fast. Since they feed at night, they may kill many small plants before being observed. They cut off the stems of young plants at the surface of the ground, but certain species climb small plants and cut only the leaves. One cutworm can kill many plants in a night.

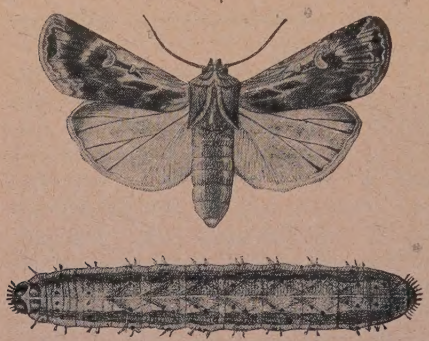

FIGURE 3.—Granulated cutworm: Moth above; cutworm, or larva, below (one and one-fourth times natural size).

Treatment.—The best remedy is poisoned bait. For use in a small garden make this by thoroughly mixing 2 level tablespoonfuls of white arsenic or paris green with 5 pounds of dry bran. Then add from 4 to 6 quarts of water in which a half pint of sorgo or cheap molasses has been mixed. Mix the poison in the morning and apply it late in the day, so that it will be moist and attractive when the cutworms begin to feed in the evening. Scatter it thinly over the garden or about the bases of the plants that have been set out. The treatment should be repeated if necessary. As this mash is poisonous, young children, livestock, and poultry should be kept away from fields where it has been applied.

Hand-picking also is effective in small gardens. The cutworms usually may be found curled up about an inch below the surface of the ground within 3 or 4 inches of the cut plants.

APHIDS, OR PLANT LICE

Small, soft-bodied insects, known as aphids or plant lice (fig. 4), usually green but varying to pink, brown, or black, collect on the ends of the twigs or shoots and on the under sides of the leaves of a great variety of plants, where they feed on the sap and often cause serious injury by curling the leaves or weakening and killing the

young shoots. The young are born alive—often several are produced in a day—and they mature within a few days. Under ordinary conditions practically only females are produced, and the rate of increase is tremendous. Plant lice ordinarily become more injurious during cool, damp weather, being held in check during warm, dry weather by various natural enemies, important among which are ladybird beetles and syrphus flies.

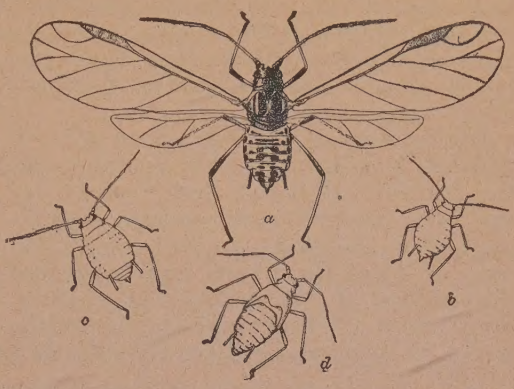

FIGURE 4.—The spinach aphid—A full-grown aphid and young ones (approximately 10 times natural size).

Treatment.—In the treatment of plant lice an ounce of prevention is better than a pound of cure. On their first appearance in the garden it is advisable to apply a spray of nicotine sulphate[4] or to dust with nicotine dust, either of which treatments should be so applied as to reach the bodies of the insects directly, as contact with the nicotine is necessary for their destruction. Strong soapsuds, fish-oil soap, or other soaps are also useful. If after attack by these pests the application of remedies is neglected, the plants may soon be too far gone to justify treatment.

LEAFHOPPERS

Leafhoppers (fig. 5) are slender, delicate insects, usually one-eighth of an inch or less in length, and brown to pale green, which have the habit of hopping to considerable distances when disturbed. Among the crops very often attacked are potatoes and beans, the characteristic injury being a whitening and curling of the leaves, with dying of the edges. In the potato this condition is commonly called "hopperburn." The eggs are laid in the leaf tissue or stalks, and two or more broods may be produced annually.

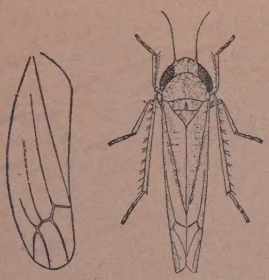

FIGURE 5.—Potato leafhopper: At the right, adult insect; at the left, wing extended, showing venation (approximately seven times natural size).

Treatment.—For the control of leafhoppers on potatoes bordeaux mixture is satisfactory. Either sulphur or bordeaux mixture is effective against leafhoppers on beans. Pyrethrum or some other contact insecticide, so applied as to make contact with the insects, is useful on other crops. Since leafhoppers live by sucking the juices from plants, they cannot be killed by stomach poisons.

SEED-CORN MAGGOT

The seed-corn maggot is the immature form of a small fly. The female fly deposits its eggs on the surface or in the soil, and the

[4] Directions for preparing insecticides are given under the heading Insecticides, p. 47.

maggot which hatches enters the soil and feeds upon decaying vegetable matter or sprouting seeds. This pest is especially destructive to the seed of beans, peas, melons, potatoes, and corn, particularly during cool, wet seasons when conditions are not favorable for the rapid germination of seeds. The flies are attracted for egg laying to lands that contain large quantities of decaying vegetable matter or freshly applied organic fertilizers, such as fish scrap, dried blood, or bonemeal.

Prevention.—Land containing a cover crop should be plowed and tilled in time to permit the complete decay of the cover crop before the planting of beans, peas, melons, potatoes, corn, or other seeds that are susceptible to maggot injury. If organic fertilizers are used, they should be applied some time before the planting of the crop or after the plants have appeared above ground. Thorough preparation of the seedbed and shallow planting to promote rapid germination of the seed aid in preventing damage by the pest. Never apply an organic fertilizer directly in the planted row.

BLISTER BEETLES

Blister beetles (fig. 6) are common farm pests and are often very destructive to vegetables, especially peas, beans, potatoes, and beets. They travel like armyworms and for this reason are sometimes called army beetles. They are hungry feeders, and often travel in lines, eating everything in their path. They are slender, somewhat soft-bodied, and of various colors, some being entirely black, others brown or yellow with black stripes or spots, and some dark gray or gray spotted with black. The "old-fashioned potato bug", an example of this group, is well known to most gardeners.

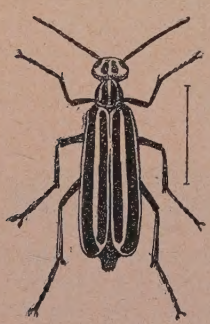

FIGURE 6.—Striped blister beetle: Adult (approximately two times natural size).

Treatment.—When the beetles are first seen, dust with sodium fluosilicate diluted with five times its weight of clay. Under some conditions this insecticide will cause plant injury. Such injury, however, is usually not severe enough to cause noticeable damage to the crop, particularly if the treatments are made when the foliage of the plant is dry. Arsenical dusts or sprays will repel the beetles, although they may not kill them. To avoid poisonous residues, spray or dust with a strong dilution of pyrethrum. In small plantings hand picking is effective, but gloves should be worn while handling the beetles because they may blister a tender skin. Also, it is often practicable to knock the beetles into pails or pans containing a small quantity of water upon which a little kerosene has been poured.

See warning regarding poisonous residues on page 47.

FLEA BEETLES

Flea beetles (fig. 7), as the name implies, are small, dark-colored beetles which, when disturbed, jump away in a manner similar to that of a flea. They injure plants by gnawing small holes through the leaves, which often appear as though fine shot had been fired through them. The beetles usually feed from the under side of the leaf. In

some cases the substance of the leaf is eaten through only to the upper epidermis. In some localities young seedlings when first sprouting may be seriously damaged by flea beetles. The plants usually attacked are radishes, cabbages, turnips, tomatoes, potatoes, and eggplants.

FIGURE 7.—Potato flea beetle: Adult. Actual length shown by line at right.

Treatment.—To protect young seedlings and larger plants, dust thoroughly with a derris and tobacco-dust mixture containing 1 percent of rotenone (p. 50). Thorough applications of bordeaux mixture, either as a spray or as a dust, are effective repellents.

GRASSHOPPERS

Grasshoppers may prove troublesome in the vegetable garden, the time of attack varying from early spring to late fall. They often strip the leaves of beets and similar plants.

Treatment.—Use the same bran mash as for cutworms, adding one finely chopped orange or lemon to the water before mixing.

WIREWORMS

Wireworms, the slender, hard, brown, wormlike larvae of click beetles or "snap bugs", often do great damage to potatoes, carrots, beets, sweetpotatoes, and onions by burrowing through the roots or tubers. The burrows are small in diameter and usually extend directly into the substance of the roots to a depth of from one-fourth to one-half inch or more. Frequently the worms themselves may be found partially buried in the burrows.

Prevention.—Deep midsummer cultivation and heavy fertilizing will reduce wireworm damage. Under some conditions soil fumigation and flooding are useful.

RED SPIDERS

Nearly all vegetables are attacked by small mites, commonly called red spiders. These mites, so small that they are not readily seen, injure plants by sucking the juices of the leaves, so weakening them that in case of a bad attack the strength and resistance of the plant are sapped, and it becomes worthless or eventually dies. In case of a bad attack great numbers of mites can be found on the under sides of the leaves, and the webs that they spin from plant to plant can be seen, with the mites themselves passing rapidly over them and gathering in swarms. The plants often become seriously yellowed or appear as though scorched by fire.

Treatment.—The best-known remedy is to dust with sulphur. Any curling or whitening of the older leaves is reason for suspecting the presence of red spiders. Watch for them and apply the treatment when they first appear, as it is hard to save the plants after they become covered with the webs. Under some conditions, particularly during hot weather, sulphur may cause injury to the foliage of squashes, melons, and cucumbers, and to the fruits of raspberry.

Spray with soap and water or with 1 ounce of potassium sulphide in 2 gallons of water. Repeat in a week, to catch the young that have hatched out. Where a stream of water from a garden hose is avail-

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able, a driving forceful spray applied to the under sides of the leaves will often effectively free them of the mites.

SLUGS AND SNAILS

Slugs and snails often do much harm in vegetable gardens, particularly in damp, shady places. They eat large ragged holes in the leaves and may completely destroy young seedling plants grown in hotbeds and coldframes, leaving a trail of slime wherever they may have crawled. Slugs are soft, slimy animals, black, gray, or brown, and often spotted with black, looking like snails without shells. Some species reach a length of from 5 to 6 inches.

Treatment.—Air-slaked lime scattered about the garden is useful against young slugs. When this comes in contact with the bodies of the slugs they throw off so much slime that they become weakened and die. Spray the plants with bordeaux mixture and distribute the bait recommended for cutworms. The bordeaux mixture will drive the slugs from the plants to the poisoned bait.

Prevention.—To avoid slugs, remove all rotten wood, boards, etc., and keep the entire garden and yard free from all kinds of rubbish in which the slugs may conceal themselves during the day.

PRINCIPAL DISEASES AND INSECTS ATTACKING SPECIFIC GARDEN CROPS

ASPARAGUS

RUST

Asparagus rust is a fungus disease marked by elongated orange or black pustules on the foliage (fig. 8). The tops yellow and die early, and the next year's crop of shoots is reduced.

FIGURE 8.—Asparagus rust.

Treatment.—Rust cannot be satisfactorily controlled by spraying with bordeaux mixture or other fungicides.

Prevention.—Plant Mary or Martha Washington asparagus, strains that have been bred by the Bureau of Plant Industry for rust resistance, vigor, yield, and quality. These strains can now be obtained from many seedsmen. Other semirust-resistant varieties are Reading Giant, Argenteuil, and Palmetto.

ASPARAGUS BEETLES

The common asparagus beetle (fig. 9), which is about one-fourth of an inch in length, is red, black, and yellow. The larvae or grubs, as well as the beetles, feed on the foliage of full-grown asparagus and at times gnaw and disfigure shoots of cutting size. The larvae are grayish and similar in size to the beetles.

Treatment.—Cut shoots early and often to prevent eggs from hatching on them. Leave occasional shoots to mature and attract the adults for egg laying, and spray these thoroughly with an arsenical. *Shoots intended for eating should not be poisoned.* Asparagus beetles attacking full-grown asparagus should be controlled by being sprayed or dusted with an arsenical such as calcium arsenate from both sides, and the next brood thus reduced.

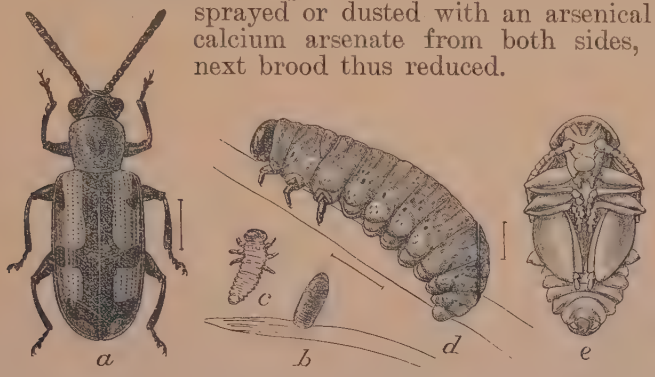

FIGURE 9.—The common asparagus beetle: *a*, Beetle; *b*, egg; *c*, newly hatched larva; *d*, full-grown larva; *e*, pupa (approximately five times natural size).

BEANS

ANTHRACNOSE, OR POD SPOT

Most gardeners recognize anthracnose or pod spot by the roundish sunken spots with dark-brown or reddish-brown borders and pink centers that it causes on the young pods (fig. 10). It also produces elongated, sunken, dark-red cankers on the stems and leaf veins and grows through the pods and causes rusty looking spots on the ripe seed (fig. 10). The causal fungus lives over winter in the seeds and on the diseased vines and attacks the young seedlings. Pod spot is most serious in moist, cool seasons and often does not occur in dry, hot summers.

Treatment.—Pull and burn the first plants showing the disease. Anthracnose is spread by wind and rain, also by insects and by the hands of pickers. Hence avoid cultivating or walking through the beans or picking them while the plants are wet with rain or dew.

Prevention.—No seed treatment has been found success-

FIGURE 10.—Bean anthracnose on pod and seeds.

ful, as the fungus is under the seed coat, where fungicides cannot reach it without also killing or injuring the seed. Rotate crops so that beans will not be planted on the same land oftener than once every third or fourth year. Wherever possible, seed grown in Colorado or other far-Western States that is free from or resistant to anthracnose should be used. The anthracnose-resistant varieties, Well's Red Kidney, Western Red Kidney, White Imperial, and Perry Marrow, all belong to the dry shell-bean type.

BLIGHT

Bean blight, a bacterial disease, causes large irregular diseased areas on the leaves, which at first are water-soaked, later become brown and brittle, and usually have pale-yellow borders (fig. 11). It attacks the stems, producing reddish cankers and sometimes becoming systemic. The stems are often girdled, and the plants then break over during storms. On the pods, slightly raised watery pustules appear which later enlarge and become irregular in shape and rusty in color (fig. 11). The disease is carried in the seed, which often becomes yellow and shriveled or shows yellow, diseased blotches.

FIGURE 11.—Bean blight on leaf and pod.

Treatment and prevention.—The same as for anthracnose. A few varieties of garden bush beans are fairly resistant to the disease: Late Stringless Green Refugee, Refugee 1,000 to 1, and Refugee Wax. The use of clean seed, when available, is most important. Seed produced in certain Western States—Idaho and California, for example—is largely free from this disease and should produce a crop relatively free from blight.

MOSAIC

Bean mosaic is marked by the mottling of the leaves into light- and dark-green areas, accompanied by the curling and stunting of the foliage (fig. 12) and by reduction of yield. The disease is carried in the seed from diseased plants and, once introduced, is spread by plant lice.

Treatment.—Prompt destruction of the first mosaic-affected plants seen and the control of plant lice will help to reduce the rapid spread of mosaic.

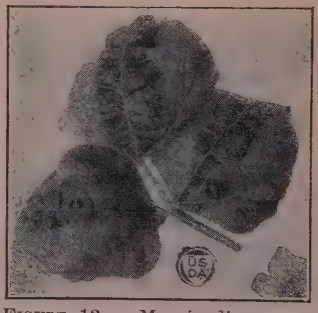

FIGURE 12.—Mosaic disease on bean leaves.

Prevention.—Avoid mosaic by planting disease-free seed saved from healthy plants where possible. When available use mosaic-resistant seed where mosaic is prevalent. The following is a partial list of dwarf garden and pole beans fairly resistant to mosaic: Green-pod varieties—Bountiful, Black Valentine, Full Measure, Burpee Stringless Green Pod, and Giant Stringless Green Pod; wax-pod varieties—Davis White Wax, Improved Kidney Wax, Burpee Brittle Wax, and Unrivaled Wax; pole varieties—Kentucky Wonder and Kentucky Wonder Wax.

RUST

The true rust, here referred to, is caused by a fungus closely related to that responsible for the common grain rust. It appears on the leaves, stems, and pods as tiny red pustules, which later become black, and causes the leaves to turn yellow and fall to the ground.

Treatment.—No treatment of seed or plants is effective in controlling bean rust. Dust with sulphur.

Prevention.—Where rust is a limiting factor, resistant varieties are available for planting. Of dwarf green-pod snap beans, the following are fairly resistant: Bountiful, Full Measure, Black Valentine, Burpee Stringless Green Pod, Giant Stringless Green Pod, Refugee 1,000 to 1, Late Stringless Green Refugee, and Extra Early Refugee. Fairly resistant wax-podded varieties are Burpee Brittle Wax, Keeney Rustless Wax, Refugee Wax, Improved Golden Wax, and Sure Crop Wax. Among pole beans, Lazy Wife, King Mammoth Horticultural, London Horticulture, and Lows Champion are fairly resistant varieties.

BEAN WEEVIL

The worst insect enemies of beans are weevils. Attack begins in the field from eggs laid on the pod. The eggs hatch into larvae, or grubs, which at once burrow through the pod into the beans, completing their growth inside. Soon after the beans are harvested the grubs change to weevils and begin to come out. A second brood of the common bean weevil may be enough to ruin a crop of beans for either human food or seed. Several broods may be produced in a year. The common bean weevil (fig. 13) is dull gray with reddish legs and is about one-eighth of an inch long.

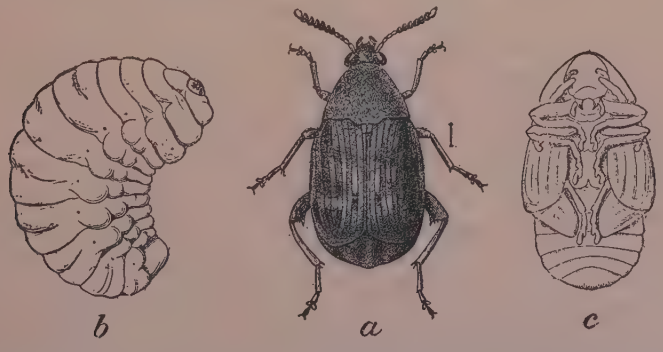

FIGURE 13.—The common bean weevil: *a*, Full-grown beetle; *b*, grub; *c*, pupa. The small straight line between *a* and *c* shows the length of the full-grown weevil.

Treatment.—Bean weevils cannot be controlled in the field. They breed in dry seed. The beans should be harvested and shelled as early in the season as possible. As soon as they are dry, i. e., have not more than 12-percent moisture content, the beans should be fumigated with carbon disulphide, hydrocyanic acid gas, or a commercially prepared mixture of ethylene oxide and carbon dioxide. Also, such seed may be treated with heat (p. 56). Small quantities of weevil-infested beans can be treated by dipping them in boiling water for 1 minute. Such seed should be spread out immediately and dried rapidly.

Prevention.—Plant only seed free from weevils. Guard treated seed from possible reinfestation by bean weevils by storing it in tight barrels or boxes, or in cloth sacks made of closely woven material (24 strands to the linear inch).

BEAN LEAF BEETLE

The bean leaf beetle (fig. 14) does much injury in the Eastern States and from Ohio southward to Louisiana. The beetles eat large round holes in the growing leaves, usually working from beneath. They also feed on such wild plants as beggarweed or tickseed. The grubs feed on the roots and main stems just below the ground, their habits being much the same as those of the better known cucumber beetles.

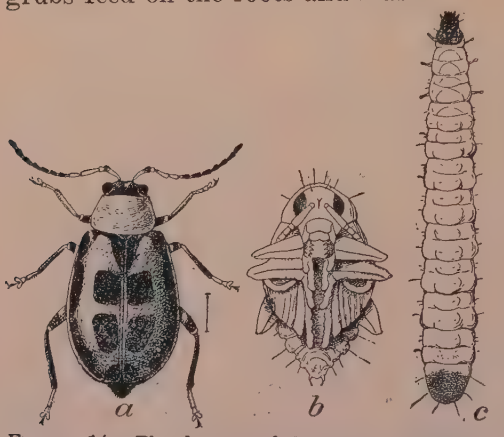

FIGURE 14.—The bean leaf beetle; *a*, Full-grown beetle; *b*, pupa; *c*, grub. The small straight line between *a* and *b* shows the length of the full-grown beetle.

Treatment.—Apply the remedies recommended for the Mexican bean beetle, as soon as the injury is noticed.

MEXICAN BEAN BEETLE

The Mexican bean beetle is a yellow or brownish ladybeetle, spotted with 16 black marks, as shown in figure 15. It has long been present in the Rocky Mountain region and is now generally distributed in the Eastern States. It destroys table beans of all kinds and feeds also on cowpeas, soybeans, and some related crops. The spiny yellow larvae, or grubs, feed on the under sides of the leaves and completely strip the plant within 1 or 2 weeks.

Treatment.—The best remedy is a spray containing derris or cube root powder or cryolite in water, applied thoroughly and carefully to the under sides of the leaves (table 1). It is important to spray as soon as the beetles appear in the field or when the eggs are first noticed on the leaves. Sprays are recommended in preference to dusts for controlling this pest. In case cryolite is used, treatments on snap beans should stop when the pods begin to form. Derris may be applied to beans even after the pods form, if necessary, because this compound will not leave harmful residues on the beans if applied at recommended dosages.

Lead arsenate should not be used on beans, as it often seriously injures the plants and reduces the yield. Except in semiarid regions, calcium arsenate may also injure bean foliage.

See warning regarding poisonous residues on page 47.

Prevention.—The destruction of crop remnants after harvest is important. All plant remnants should be plowed under at least 6 inches deep.

FIGURE 15.—The Mexican bean beetle: *a*, Larva; *b*, beetle (three times natural size). The larger holes at the top of the leaf are characteristic of the feeding of the adult beetle; the lower portion of the leaf shows the feeding of the larvae.

BEAN APHID

The bean aphid is a very small, blackish plant louse that may damage beans in all parts of the United States.

Treatment.—(See Aphids, or plant lice, p. 4.)

BEETS AND CHARD

LEAF SPOT

In beet or chard leaf spot numerous small round to irregular dead spots with white centers and purple borders appear on the leaves

(fig. 16). They are caused by a fungus that attacks both crops, often causing the leaves to curl, dry up, and die.

Treatment.—For beets, spray with 4–4–50 bordeaux mixture when the first spots are noted and repeat at 10-day intervals. For chard, pick off and burn the badly spotted leaves and stimulate new growth by liberal applications of nitrate of soda.

Prevention.—Crop rotation.

FIGURE 16.—Beet leaf, showing leaf spot.

FIGURE 17.—Beet webworm: Above, moth; below, full-grown larva (approximately twice natural size).

BEET WEBWORMS

Several kinds of webworms attack beets and eat the leaves, which become webbed together on the growing plant. The worst of these pests, known as the beet webworm, is shown in figure 17.

Treatment.—Spray with paris green. *See warning regarding poisonous residues on page 47.*

Prevention.—The garden should be kept free from weeds such as pigweed, which will encourage webworms and help them to spread.

CABBAGE

Many of the diseases that attack cabbage also cause damage to other crops of the same family, including cauliflower, turnips, brussels sprouts, and collards, as well as some related wild plants.

CLUBROOT

Clubroot, also called "fingers-and-toes", is caused by a minute slime mold which enters the roots and produces large irregular swellings and malformations like those shown in figure 18. Diseased plants are stunted, have a sickly yellow appearance, often wilt during the heat of the day, and generally fail to head. The trouble may attack the plants in the seedbed or after they are set out.

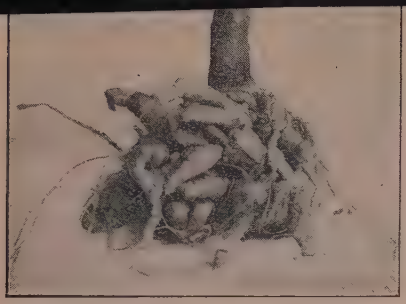

FIGURE 18.—Cabbage plant with large knots on the roots, caused by clubroot.

soil in which seed is to be planted. Burn diseased plants. Do not put them on manure or compost piles.

plants are home-grown, sterilize the

FIGURE 19.—Cabbage plant stunted and leaves curled by yellows.

Cabbage plants attacked by black rot usually have yellowed leaves with areas on the edges showing blackened veins (fig. 20), and the

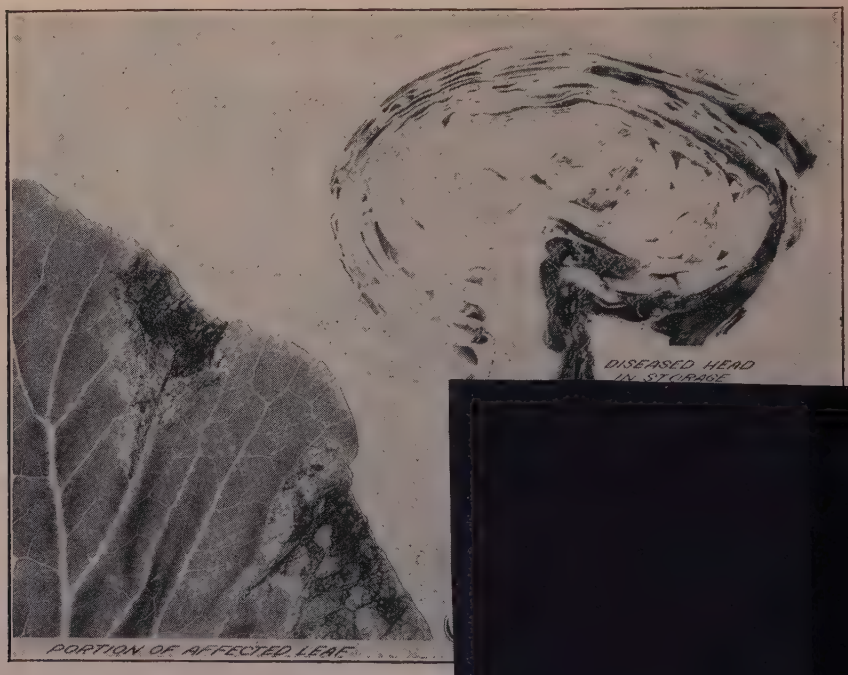

FIGURE 20.—Cabbage leaf and he

inside of the stems exhibits a black r
black rot at any time during their g
early in extreme cases or fail to for

Treatment.—There is no treatment that will stop the disease when once started. Pulling and burning affected plants as soon as the disease is noted helps to prevent the spread of the trouble.

Prevention.—A long crop rotation in which neither cabbage nor related plants are allowed to grow on infested land is very important. Disinfect the seed in mercuric chloride solution before planting it (p. 46), or treat it for 30 minutes in hot water at 122° F. A higher temperature may kill the seed. Plant it in seedbed soil known to be free from black rot, or in disinfected soil.

The leaves often turn purple, and later the whole plant wilts so the tips of the leaves rest on the ground. The disease is carried on the seed and persists in the soil. It is often spread from diseased to healthy plants in the seedbed by water spattered on the foliage during sprinkling or during rainstorms. Other wild and cultivated members of the cabbage family are also susceptible to this disease.

Treatment.—Pull and burn diseased plants as soon as they are found in the seedbeds. Prevent the spread of the disease by being careful in watering to avoid wetting the foliage and by protecting the seedbed from rain.

Prevention.—Follow the preventive measures suggested for black rot.

COMMON

Treatment.—Dust with a mixture composed of equal parts of pyrethrum powder and tobacco dust. Watch for the first appearance of the larvae and blow the mixture well down into the crowns of the plants. Repeat the application in half an hour to kill the larvae forced from their protecting webs by the first application. One or two treatments are usually sufficient.

CELERY CATERPILLAR

Celery and related plants are often attacked by a curious caterpillar, which when mature is about 1½ inches long and green in color, ringed closely with black. It has the strange habit of protruding two yellow filaments from near the head when disturbed. This pest is the young of the handsome black swallowtail butterfly, spotted with yellow, so often observed about celery, parsnips, parsley, and carrots.

Treatment.—This pest is rarely sufficiently abundant to cause serious injury. Hand-picking will usually control it.

CUCUMBERS, MUSKMELONS, AND SQUASHES

WILT

Cucumber, muskmelon, and squash plants when attacked early by the bacterial wilt disease usually wilt, dry up, and die very quickly (fig. 28). This is usually the first disease to appear in spring, often killing plants when 6 to 8 inches tall, and may continue to cause injury throughout the season. It is caused by bacteria which enter and multiply in the water vessels, thus cutting off the water supply and injuring the plants. Cucumbers are most susceptible to wilt, and squashes are least affected.

FIGURE 28.—Cucumber plant attacked by bacterial wilt.

Treatment.—Pulling and burying or burning wilted vines during the early part of the season will assist in controlling wilt. Since striped and spotted cucumber beetles are the principal if not the only means of over-wintering and spreading wilt, it is important that they be controlled by using the method given on page 26, enclosing the plants in insect-proof cages early in the season, followed by spraying with 2–4–50 bordeaux mixture and calcium arsenate.

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MOSAIC

Cucumber, muskmelon, and squash plants attacked by the mosaic or white-pickle disease are stunted and have wrinkled or mottled yellow and green leaves. The yield of fruits is frequently very much reduced. The affected cucumber and squash fruits are often crooked and covered with green warts (fig. 29), or they may be nearly white. When badly diseased they are not good to eat. Many affected muskmelons remain small and are not edible. The disease also attacks wild cucumbers, the common milkweed, pokeweed, and groundcherry, and other wild and cultivated hosts, and lives over winter in their seed or roots. In some sections the wild or bur cucumber is used as an ornamental vine on the garden wall or the back porch, and in many cases it is the means of carrying mosaic from one season to another. It should be replaced by clematis or other vine. Mosaic is carried from these wild hosts to the cultivated vine crops in the spring by the striped cucumber beetles and other insects, and by them and also by pickers is spread from plant to plant in the garden.

FIGURE 29.—Warty cucumber affected with mosaic.

Treatment.—If only a few hills of cucumbers are grown in the garden the plants should be protected as long as possible with cheesecloth-covered cages to keep off the striped cucumber beetles (see p. 26 for details of beetle-control methods) and later sprayed or dusted as necessary to control lice and beetles.

Prevention.—Remove all milkweed, pokeweed, wild cucumber, groundcherry, and other wild host plants of mosaic in or near the garden to prevent so far as possible the overwintering of the disease.

ANTHRACNOSE

Anthracnose is a fungus disease that attacks cucumbers and melons particularly, causing roundish, brown spots one-fourth to one-half inch in diameter on the leaves (fig. 30) and sunken elongated cankers on the stems, often killing both crops prematurely and either preventing the growth of the melons or seriously injuring their quality and causing a ripe rot of both cucumbers and melons. Green melons are also sometimes attacked, and round to irregular sunken spots with pink centers occur as a result. The trouble becomes noticeable in the latter part of the season and, if warm, moist weather prevails, may kill the vines in 2 or 3 weeks.

Treatment.—Timely and thorough spraying with 2–4–50 bordeaux mixture (p. 45), will hold the disease in check. Begin to spray as soon as the very first signs of disease are seen or soon after the vines begin to run, and continue the spraying at weekly intervals.

Prevention.—Since the disease lives over winter in the soil and probably also on the seed, preventive treatment is very important. Rotate so that vine crops will not follow vine crops oftener than every third year, and disinfect the seed with mercuric chloride before planting it (p. 46.)

DOWNY MILDEW

Like anthracnose, downy mildew, also a fungus disease, causes spots on the leaves of most cucurbits, which soon curl, dry up, and die. The spots are smaller than anthracnose spots, however, and are yellowish above and purplish underneath. When warm, moist weather occurs this disease kills the plants more quickly than anthracnose. There is no conspicuous fruit spotting, but the early death of the foliage results in immature, insipid fruits. Downy mildew occurs most frequently and severely in the Atlantic Coast and Southern States.

FIGURE 30.—Cucumber leaf showing anthracnose spots.

Treatment.—Spraying as for anthracnose, giving special attention to getting the spray on the under sides of the leaves, will keep the plants alive 2 to 3 weeks longer than unsprayed plants live.

Prevention.—Rotate crops.

ANGULAR LEAF SPOT

Angular leaf spot, caused by bacteria, attacks particularly the leaves of cucumbers, causing angular spots one-sixteenth to one-eighth of an inch across. At first the spots are water-soaked; later they dry and whiten and often drop out. The cotyledons are first attacked, as the disease is seed-borne. During continued wet weather in midseason considerable damage may be caused. The causal bacteria live over winter on diseased vines, in the soil, and on the seed.

Treatment.—Angular leaf spot can be readily controlled by spraying as for anthracnose, but preventive treatment is much simpler.

Prevention.—Disinfecting the seed with mercuric chloride before planting it is the simplest and most effective form of control when combined with crop rotation (p. 46).

LEAF SPOT

Leaf spot is a fungus trouble that is most serious on muskmelons, but it also attacks cucumbers, particularly in the Western States. The leaves show small irregular, brown, dead spots, and on muskmelons the leaves soon curl up and die (fig. 31). On cucumber leaves it causes dead areas that soon fall out, leaving ragged holes and edges.

Treatment.—Spray with 2–4–50 bordeaux mixture, as for anthracnose (p. 45).

Prevention.—Rotate crops, and where possible use resistant varieties.

FIGURE 31.—Muskmelon leaf spot.

STRIPED CUCUMBER BEETLE

The striped cucumber beetle (fig. 32), as well as the twelve-spotted cucumber beetle, lives throughout the Eastern States. In other States there are several other kinds of beetles that have about the same habits and can be treated in the same way. The common form in the East, the striped cucumber beetle, sometimes called the striped bug, melon bug, or "cuke bug", is about one-fourth of an inch long and yellow, and has three black stripes. The worm, or larva, is slender and white, and brownish at the ends. Most of the injury is done by those beetles which live through the winter and eat the young plants in the spring. The beetles also injure older plants by eating the leaves and gnawing the stems and roots. The beetles usually come out in April or May. Late in the season they gather around the stems and leaves of cucumbers, but on the first cool nights in the fall they seek shelter. In the larval stage this insect causes damage by boring into or feeding on the roots and on the stems at and below the soil line. These beetles also spread diseases of cucumbers, squash, and melons.

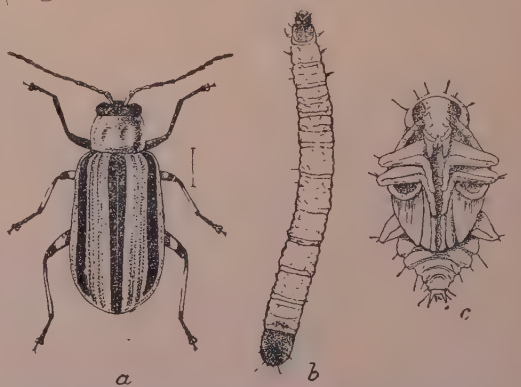

FIGURE 32.—Striped cucumber beetle; *a*, Beetle; *b*, rootworm; *c*, pupa. The small line at the right of the beetle represents its natural length.

Treatment.—The simplest protection from this and other beetles in the garden is to cover each young plant with a frame made by placing the halves of a barrel hoop in the position shown in figure 33

and covering the frame thus made with cheesecloth. Good cheesecloth must be used. The beetles easily go through mosquito netting, and anything heavier than cheesecloth keeps the light from the plants. The lower edges of the cloth must be held down to the ground tightly by stones or other weights or the beetles will burrow underneath. Rectangular cheesecloth-covered frames of any size and shape desired can also be made with inch-square corner pieces to which strips of lath are nailed.

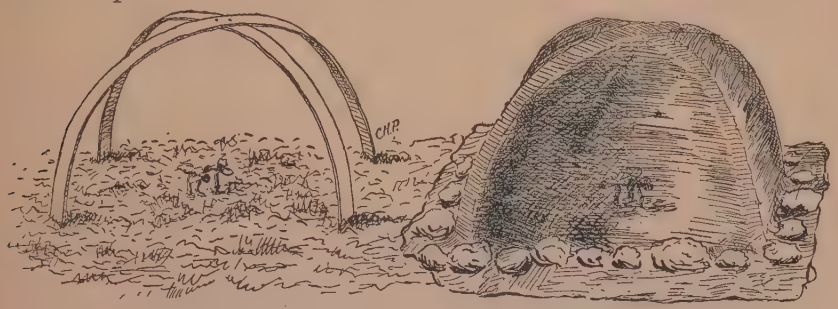

FIGURE 33.—Barrel-hoop and cheesecloth cover for cucumber and squash plants, to protect them from insects.

Applying nicotine dust to the beetles gathered on the plants, taking care that it comes in contact with the insects themselves, is also very satisfactory. A mixture of 1 pound of calcium arsenate with 15 pounds of gypsum or land plaster is also useful. Bordeaux mixture with calcium arsenate added drives away the beetles and prevents injury to the leaves so treated.

It is reported that a derris-dust mixture, containing 0.5 percent of rotenone, with gypsum (land plaster) or talc as a diluent, is an effective remedy when applied to the beetles gathered on the plants. For the preparation of home-mixed derris dust mixture see page 50.

See the warning regarding poisonous residues on page 47.

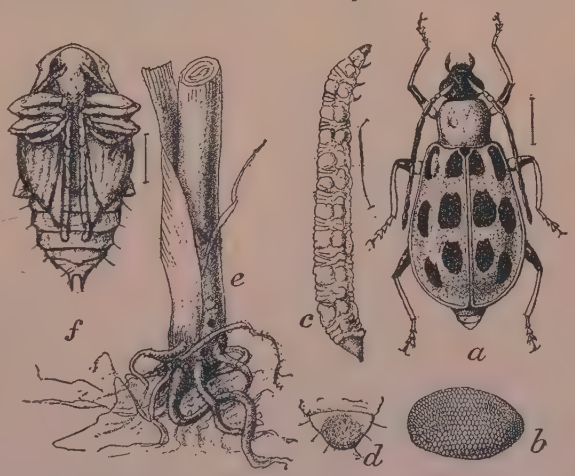

FIGURE 34.—Twelve-spotted cucumber beetle: *a*, Beetle; *b*, egg; *c*, rootworm; *d*, anal segment of larva; *e*, work of rootworm on corn root; *f*, pupa. The small lines at the right show the natural size.

TWELVE-SPOTTED CUCUMBER BEETLE

The twelve-spotted cucumber beetle (fig. 34), which is a little larger than the striped cucumber beetle, often eats cucumber leaves, causing much injury. The larva lives mainly on grass and corn roots, but it also eats bean leaves and pods.

Treatment.—The protective measures used for the striped cucumber beetle are the best remedies.

MELON APHID

The melon aphid (fig. 35), commonly called the melon louse, is very small and greenish or nearly black. It sucks the juices of cucumbers and many other plants. It occurs from early spring and summer till late autumn and early winter. In seasons that favor its increase it often appears in great numbers and does much damage, gathering in masses on the under sides of the leaves, causing them to curl, shrivel, and lose color, and stopping the growth of the fruit. It often kills the plants outright. An attacked melon plant is shown in figure 36. The melon aphid gives off honeydew, a honeylike juice. When the aphids become very thick the honeydew covers the leaves with a thin sticky coating to which the white skins of the aphids adhere, and this attracts attention to the injury, as do also the wilting and dying of the plants.

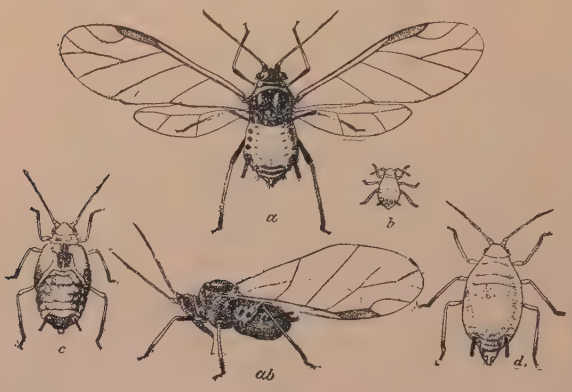

FIGURE 35.—The melon aphid or louse: *a*, and *ab*, Winged aphids; *b*, newborn young; *c*, nymph stage; *d*, wingless female (approximately 10 times natural size).

Treatment.—The best remedy is dusting with nicotine dust beginning as soon as the aphids first appear. Spraying with nicotine sulphate is also helpful.

FIGURE 36.—Melon leaves curled by the melon aphid.

COMMON SQUASH BUG

Squashes, gourds, and pumpkins suffer from the same pests as cucumbers. They may also be damaged by the squash bug (fig. 37), commonly known as the stinkbug on account of its disagreeable odor. It feeds on the plant juices.

Treatment.—Pick off the insects by hand before they lay their eggs. The shiny brown eggs are easily seen on the under side of the leaves and can be crushed. The full-grown bugs are hard to kill but may be trapped by placing small pieces of board, shingle, or bark on the ground near the plants. The insects will hide under these pieces of wood during the day. The traps should be examined each morning and the bugs killed.

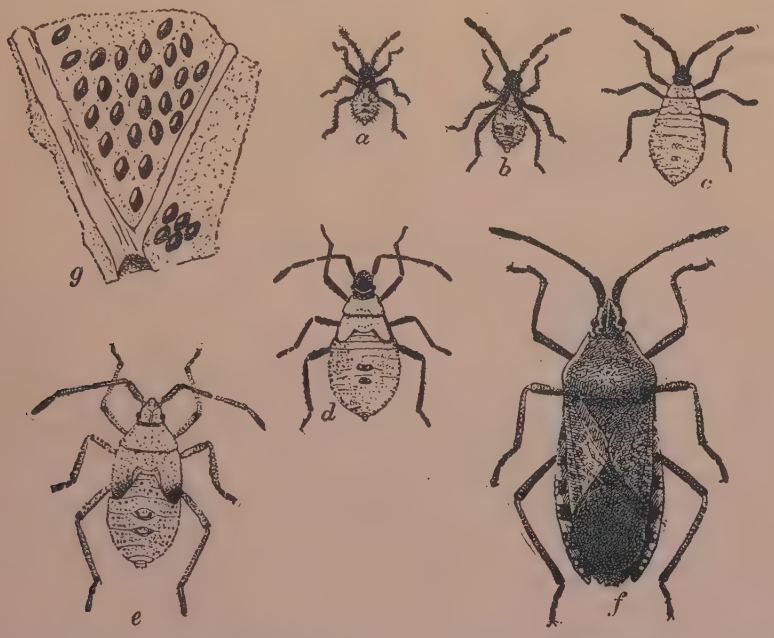

FIGURE 37.—Common squash bug: *a*, *b*, *c*, *d*, *e*, Partly grown young; *f*, full-grown bug; *g*, eggs (approximately two and one-half times natural size).

Some relief may be obtained by spraying or dusting the young plant bugs on the plants with nicotine sulphate, as described for aphids on page 5, or by dusting with derris or pyrethrum, as described for cabbageworms on page 18. To be at all effective these sprays or dusts must actually hit the young plant bugs. At ordinary strengths, these materials will not kill the old plant bugs.

SQUASH BORER

After cucumbers and melons have made good growth they are sometimes attacked by the squash borer, or squash-vine borer (fig. 38), which, however, is much more destructive to pumpkins and squashes, especially the Hubbard and summer bush squashes. This is the large white grub that bores into the stems, sometimes cutting them almost through near the roots.

Treatment.—When the borers attack cucumbers it is almost impossible to kill them without killing the plants. The borers may be cut out of squash vines by slitting the stems of the vines lengthwise. Afterward those portions of the vines should be covered with earth to help the plant grow extra roots. Keep the plants growing vigorously and free from other insects and diseases. It is reported that nicotine sulphate, 1 part in 100 parts of water, applied to the basal part of the vines will reduce infestation. Four or more applications at weekly intervals, beginning in late June or early July, may be required.

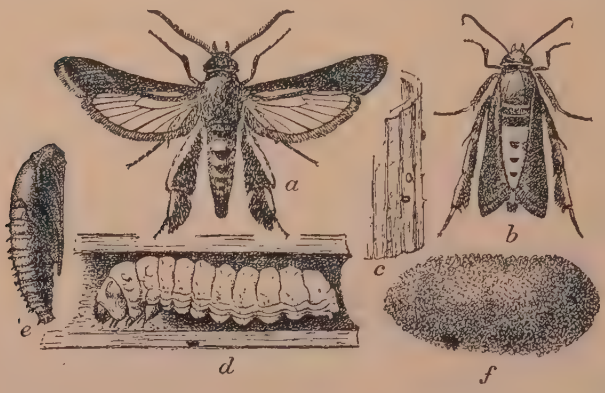

FIGURE 38.—Squash borer: *a*, Moth with wings spread; *b*, moth at rest; *c*, egg on section of vine; *d*, caterpillar or grub in squash vine; *e*, chrysalis; *f*, chrysalis cell from ground (enlarged one-third).

It is also reported that dusting with a derris and talc mixture containing 1 percent of rotenone or with a derris, sulphur, and clay mixture (20–25–55) containing 1 percent of rotenone will aid in reducing the damage done by this pest. For the preparation of home-mixed derris-dust mixture see page 50. The dust should be applied thoroughly to the stems and basal part of the vines late in June or early in July. Three or more applications at 10-day intervals may be required.

Prevention.—The dead vines and old plants should be destroyed as soon as the crop is gathered. Harrow the garden lightly in the fall and plow deeply in the spring to keep the moths from coming out.

MELON WORM AND PICKLEWORM

Two species of worms, known as the pickleworm and the melon worm, commonly attack the fruit of melons, cucumbers, squashes, and pumpkins, especially in the South. These worms vary from white to light green in color and are about three-fourths of an inch long when fully grown. The pickleworm in its early stages bores principally into the buds, blossoms, stems, and leafstalks of the plant. After the fruit forms it bores into the fruit. The melon worm feeds extensively on the leaves of the plants and also bores into the fruit.

Treatment.—Recent experiments have indicated that these pests can be controlled, particularly on fall-grown squash in the coastal areas, by dusting with a derris and sulphur mixture containing 1 percent of rotenone. A dust mixture composed of equal parts by weight of pyrethrum with clay or talc and sulphur has proved of some value. Cryolite, mixed with clay and sulphur in the ratio of 1 pound of cryolite to 1 pound of clay and 2 pounds of sulphur, may be used to advantage in early treatments.

Treatments should begin when the worms first appear on the leaf buds of the plant, which is usually within a week or 10 days after the plants appear above ground. They should be continued at 7-day intervals as long as the worms are present or the crop is being harvested. Extreme care should be exercised to cover the growing tips of the plants with the dust, because the worms feed extensively on this part of the plant before boring into the fruits, stems, and vines.

No satisfactory control has been developed as yet for these pests on cucumbers, melons, or pumpkins. The treatment recommended for the protection of squashes, however, might be employed on these crops to advantage.

See the warning regarding poisonous residues on page 47.

ONIONS

SMUT

The most common and serious disease of onions in the Northern States is smut, which is caused by a fungus that lives in the soil where smutted onions have grown. It produces blisters full of a black powdery mass of fungus spores on the leaves of young plants (fig. 39), often killing them and reducing the yield. The fungus lives over winter in the soil of fields where the disease has occurred.

Prevention.—If possible plant onions on land where the disease has not occurred. If this cannot be done, sprinkle formaldehyde solution (1 teaspoonful to 1 quart of water) in the drill after the seeds have been dropped before covering them, using 3 to 4 quarts of the solution to each 100 feet of row.[5]

FIGURE 39.—A young plant affected with onion smut. Later the blisters break and expose black powdery spore masses.

BULB ROT

A fusarium disease causes the bulbs to rot as they approach maturity. This disease is important in the Central and Western States and is worse where high temperatures prevail.

Prevention.—Sanitary measures, the careful sorting out of diseased bulbs at harvest time, and rotation of crops are the chief means of controlling this disease.

ONION THRIPS

The onion thrips is a very small whitish or brownish insect, often incorrectly called onion louse, which by feeding in large numbers on the leaves causes injury known as white blast, white blight, or silver-

[5] For further details as to prevention, see Farmers' Bulletin 1060, Onion Diseases and their Control.

top. The insect often completely destroys large fields of onions. It also attacks cauliflower, cabbage, cucumbers, melons, pumpkins, squashes, parsley, tomatoes, kale, turnips, and seed beets, feeding on the under sides of the leaves, which become covered with fine white spots, showing where the insect has withdrawn the sap of the leaf for food.

Treatment.—Careful and frequent spraying with nicotine sulphate will protect the crop.

ONION MAGGOT

The onion maggot (fig. 40) is the worst northern onion pest. It eats into the bulb, starting decay, and often destroys the whole onion. The onion maggot is the larva of a small gray fly which looks like a small housefly. Two or three broods may be looked for each year, and the first flies usually appear about apple-blossom time.

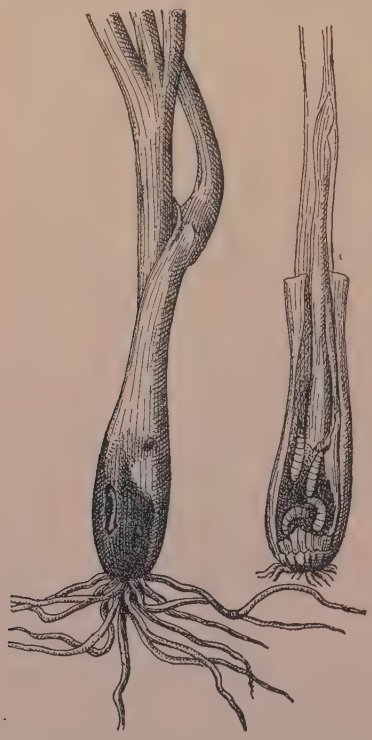

FIGURE 40.—Onion maggots at work in the bulb of a young plant. At the right, an inner view of the same (maggots approximately one and one-half times natural size).

Treatment.—Use bichloride of mercury prepared as recommended for the cabbage maggot and pour along the rows. When seed is sown, begin the treatment when plants are an inch high; if sets are planted, when they begin to sprout. Repeat at 10-day intervals, making from five to seven applications. After the maggots enter the bulbs treatment is useless. A lubricating-oil emulsion made by pouring 1 gallon of bordeaux mixture into 1 gallon of light lubricating oil, pumping the mixture back upon itself until a good emulsion is secured, and diluting this with 40 gallons of water is also useful in large plantings. Cover the plants and the soil around them thoroughly with this emulsion, and repeat the treatments three or four times, at weekly intervals.

PEAS

ASCOCHYTA BLIGHT, OR POD SPOT

Ascochyta blight or pod spot produces irregular-sized spots on the leaves, stems, and pods; on the leaves they may show concentric circles (fig. 41). Small dark fruiting bodies about the size of a pin point occur in these more or less circular spots. The spores are enclosed in these receptacles and on escaping may fall on other plants and serve as sources of new infections. On the stems these spots may occur from the soil line up for a foot or more, and on the pods they are usually sunken (fig. 41). The fungus penetrates to the seed, in which it lives over winter, and may start the disease again the next year.

Treatment.—There is no effective treatment for a diseased crop.

Prevention.—Since the disease is seed-borne and may also be carried over winter on diseased vines, the most effective control measures require the destruction of diseased vines by plowing them under deeply, the use of a long crop rotation (3 or more years between pea crops), and the planting of clean seed of the least susceptible varieties. The varieties now available that are least susceptible to pod spot are Short Admiral, Badger Special, Champion of England, Horal, Horsford, Perfection, and Advancer. Seed grown in the semiarid sections of the Northwest is most likely to be free from diseases.

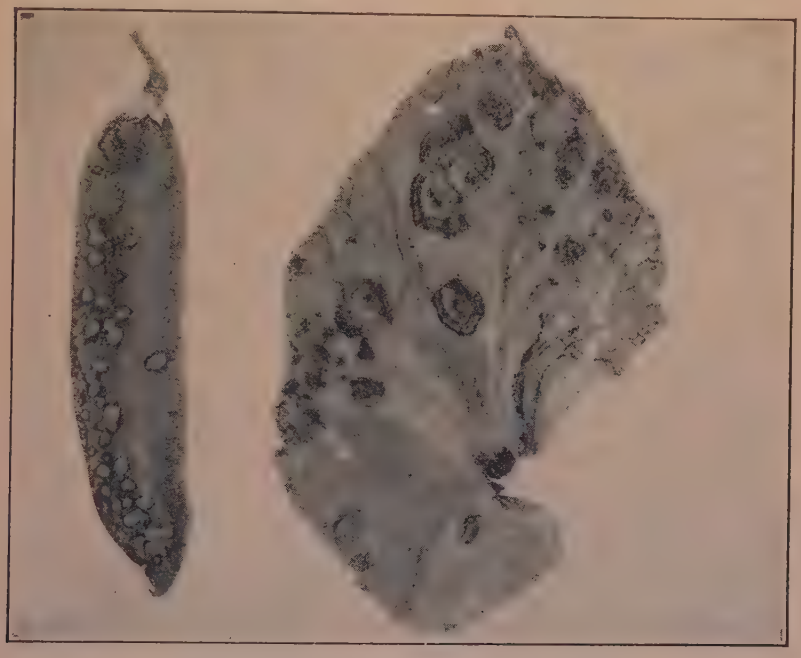

FIGURE 41.—Ascochyta blight on pea pod and leaf.

ROOT ROTS

Peas affected by root rot do not grow vigorously; they often turn yellow, and sometimes die at flowering time. The stem below ground and the roots will be found decayed and yellowish brown, brick red, or black (fig. 42). The yield of peas is often seriously reduced. Several fungi that live in the soil are responsible for this trouble.

Treatment.—No treatment is effective for diseased crops.

Prevention.—Rotation of crops, allowing 3 or more years between pea crops, is the best known method of control. Excessive soil moisture favors root rots; hence the selection of well-drained soils for the crop is important.

BACTERIAL BLIGHT

Bacterial blight attacks leaves, stems, and pods, causing large, water-soaked lesions on the pods and irregular spots on the leaves that may show a white to cream-colored shiny ooze on the surface

(fig. 43). The disease occurs in many localities and may cause considerable damage. It is seed-borne, but probably does not survive on diseased vines.

Treatment.—No effective control measures are known after the disease appears in the field.

Prevention.—The use of clean seed grown in dry-land sections of some of the Western States offers the best possibility of avoiding infection.

FIGURE 42.—The feeding roots of peas below the attachment of the seed are sometimes entirely rotted away by root rot. Similar injuries may be caused by several other organisms.

FUSARIUM WILT

Fusarium wilt is caused by a fungus (*Fusarium*) that lives in the soil and enters the water vessels of the roots and stems, with the result that the lower leaves turn yellow and the plants become stunted. The interior of affected stems becomes lemon-colored, and plants attacked while young may wilt or die (fig. 44).

Treatment.—There is no cure for pea wilt, since the causal fungus will live in the soil indefinitely.

Prevention.—Wilt can be controlled only by planting wilt-resistant varieties, several of which are now available, viz: Bliss Everbearing, Alderman, Dwarf Alderman, Rogers No. 93, Alaska, and Stridah. Other partly resistant varieties are Extra Early, First and Best, World Record, and Tall Telephone.[6]

FIGURE 43.—*A*, Water-soaked, irregularly shaped, slightly sunken spots on pea pods caused by bacterial blight. The seed may be invaded by the parasite and serve as a source of infection for the new crop. Such seed should not be planted. *B*, Leaves attacked by bacterial blight. These spots start as small, water-soaked areas, which gradually kill part of the leaf. Sometimes the injury is so extensive that the plant dies.

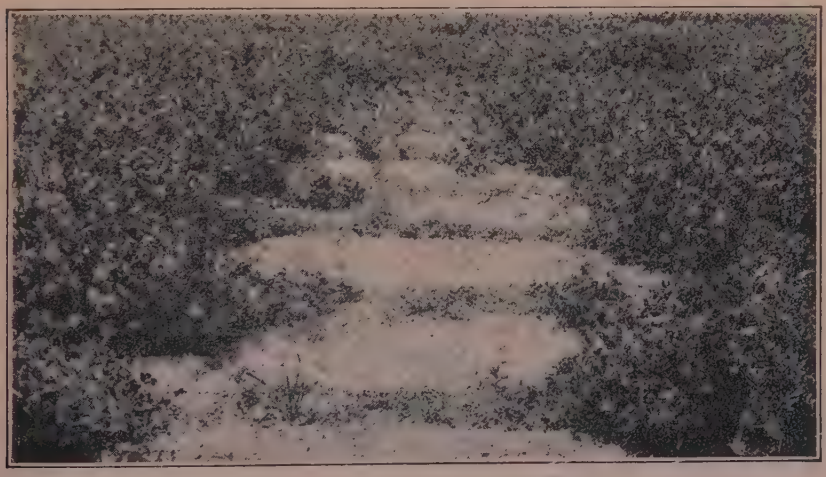

FIGURE 44.—Area on which the pea plants have been killed by fusarium wilt.

PEA APHID

The pea aphid, one of the largest of the plant lice, is about one-eighth of an inch long and pea green. The aphids gather in clusters

[6] For further information on pea diseases see Farmers' Bulletin 1735, Pea Diseases and their Control.

about the tips of the young vine. Later they attack the stem and pods, sapping the life of the plant.

This aphid also feeds on clover, alfalfa, field peas, and several weeds.

Treatment.—Nicotine sulphate as a dust or spray is a good remedy if used when the insects first begin to attack the plants in early spring. The aphids can also be knocked from the vines onto the ground by means of a brush of small twigs or a pine bough with the leaves left on. On a warm, sunny day they are killed by the heat of the ground, and few, if any, ever return to the plants.

PEA WEEVIL

Seed peas often each have a single round hole made by a pea weevil or pea "bug." This insect is about one-fourth inch long and is thickly covered with brownish scales with black and white markings. Often every pea in a pod is infested with a weevil. In dry seed the chamber under the skin, in which the insect lives, can be seen plainly. Many seeds that have been attacked will start to grow, but the plants are likely to be weak. Since this weevil has only one brood a year it is more easily treated than is the bean or the cowpea weevil.

Prevention.—Dried peas intended for use as seed or as food should be harvested as early in the season as possible. As soon as they are dry the peas should be fumigated with carbon disulphide or hydrocyanic acid gas or a commercially prepared mixture of ethylene oxide and carbon dioxide (p. 56). Also, such seed may be treated with heat (p. 56). Small quantities of dried peas can be kept in a warm room, in a tight bag or box, for one full season before they are planted. The weevils will come out of such seeds and die. Do not plant seeds that have been injured seriously by weevils. All seed peas known to contain any living weevils should be fumigated or heated before being planted. Peas that are left on the ground after harvest or that for some reason have been left unharvested often contain large numbers of weevils. These can be destroyed by burning over the field or by plowing them under deeply and cleanly as soon as possible after the usual time of harvest. Pea hay of the previous season often contains weevil-infested peas and should be fed to livestock or destroyed by burning before the next crop of peas comes into bloom.

In weevil-infested districts, peas grown for canning or for the green-pea market should be harvested as soon as they reach the edible stage, because the older peas are more likely to be infested than the younger ones. The hazard of pea-weevil infestation in cannery or market peas is greatly increased when the seed is grown in districts where the weevil is numerous. The growing of peas for seed in a pea-canning district may increase the hazard of infestations in the cannery peas.

Elimination of weeds and brush along the garden fence and the borders of fields aids in reducing the number of overwintering weevils.

FOUR-SPOTTED BEAN WEEVIL AND COWPEA WEEVIL

The four-spotted bean weevil and the cowpea weevil are similar in appearance and habits. They prefer cowpeas as food, but in the

South they also attack table beans, chickpeas, and peas; in fact, all such seeds sufficiently large to sustain a single larva. They differ from the true pea weevil in that they are capable of producing several broods each season in dry seeds.

Treatment.—Same treatment and prevention as for the bean weevil (p. 11).

POTATOES

SCAB

Common scab (fig. 45) appears as rough-pitted spots on the potato tubers and is due to a soil fungus. Severely attacked potatoes are covered with scabs, which make an unsightly product and cause waste in paring. The disease lives in the soil and is also carried on the tubers.

FIGURE 45.—Tuber unfit for planting because of potato scab.

Treatment.—The control of scab is entirely preventive.

Prevention.—If possible, plant on land known to be free from scab infestation. Do not use lime, fresh stable manure, or wood ashes for fertilizer on scab-infested land where potatoes are to be planted. Flowers of sulphur or finely ground sulphur broadcast, one-half to 1 pound per 100 square feet, has given control on some soils, though it may cause injury to certain other crops in the rotation, especially crucifers. Do not plant badly scabbed seed, and treat all seed potatoes just before cutting in formaldehyde or mercuric chloride solution (p. 46). Scab-resistant varieties, like Russet Rural and Netted Gem, may be planted on scab-infested land.

LATE BLIGHT

In years when cool, moist weather occurs during late July and August, late blight often causes great potato losses, particularly in the Northern States. The disease, due to a fungus, attacks the leaves and stems, causing irregular dark, dead areas (fig. 46), killing the plants prematurely, and reducing the yield. In moist, cool weather the disease spreads very fast, killing the plants in a few days. Later it produces a brown rotting of the tubers (fig. 47), which continues in storage.

Treatment.—Late blight can be controlled by thoroughly spraying the plants with 4–4–50 bordeaux mixture, beginning when the disease is first seen. Repeat the spraying every 10 to 14 days in dry weather and every 7 to 10 days in moist weather.

Great care and thoroughness must be used to keep the foliage covered at all times with a thin film of the spray mixture. Potatoes showing rot at digging time should not be stored with the sound ones.

Prevention.—Select tubers free from late blight rot for planting, since the disease lives over winter in the diseased potatoes.

FIGURE 46.—Potato leaf and stem injured by late blight.

FIGURE 47.—Potato tubers affected with late blight rot.

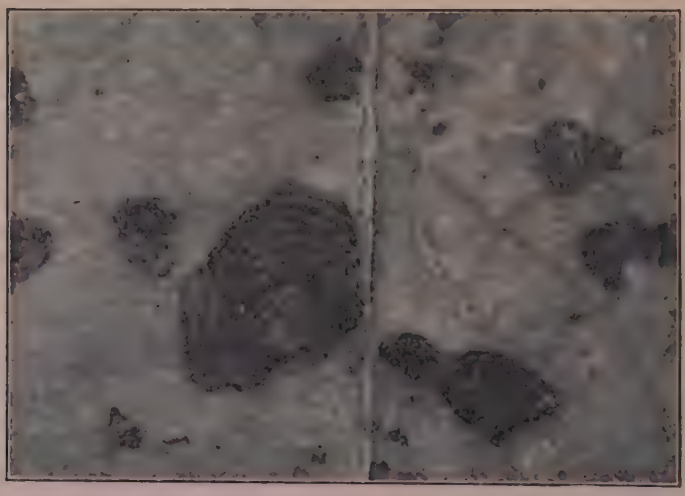

FIGURE 48.—Early blight spots on potato leaf (considerably enlarged to show target-board markings).

EARLY BLIGHT

Early blight is a fungus trouble that usually appears in early July in the Northern States, causing on the leaves dark roundish to irregular spots with characteristic target-board markings (fig. 48). Moist warm weather is most favorable for its development.

Treatment.—Spray as for late blight control.

WILT AND DRY ROT

The wilt due to fungi growing in the water vessels is marked by a yellowing and drooping of the foliage in hot weather and slow wilting of the plants, resulting in reduced yields. The interior of the stems and tubers shows a brown ring (fig. 49), and subsequently the tubers may dry-rot in storage. The fungi causing the disease are carried in the affected tubers, which are thus made unfit for food or seed. These fungi live for long periods in the soil.

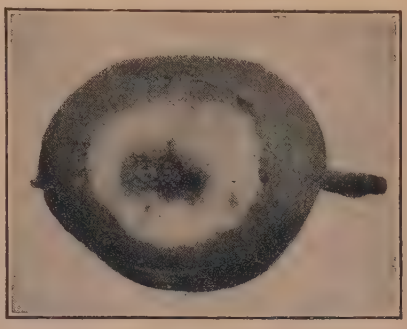

FIGURE 49.—Potato showing stem-end browning due to wilt.

Treatment.—No treatment can save affected plants.

Prevention.—Seed potatoes showing any internal discolorations should be discarded. Use only the best disease-free seed. A long rotation helps to reduce the disease in the soil. Where the disease is very prevalent, the use of whole small tubers is preferable to cut seed, provided they are known not to have come from weak or diseased plants.

MOSAIC AND LEAF ROLL

FIGURE 50.—Potato leaves attacked by mosaic.

Mosaic and leaf roll belong to the group of so-called "virus diseases" which are known to be carried in the tubers from diseased plants and to be spread by insects. They are the most serious potato diseases by reason of the marked reduction in yield which they cause and also on account of the difficulty of securing healthy seed, which are essential to the production of a healthy crop.

Mosaic is characterized by light- and dark-green mottling of the leaves, often accompanied by crinkling and dwarfing (fig. 50) and in severe cases by pronounced stunting of the plants.

Leaf roll is recognized by the yellowing and dwarfing of the plants and the upward rolling of the lower leaves, whose texture is leathery to the touch (fig. 51).

Treatment.—The control of aphids will delay the spread of these diseases.

Prevention.—The use of seed free from disease is the only known control measure. Many of the Northern States have a potato-inspection and seed-certification service, and growers whose fields, as shown by one or more inspections, are sufficiently disease-free are given a certificate and are allowed to sell their crop as "certified seed." This certified seed is usually better than ordinary seed, giving larger yields of healthier tubers. All home gardeners should buy only certified seed stock when available.

FIGURE 51.—Curling of potato leaves caused by leaf roll.

COLORADO POTATO BEETLE

Both larvae and adults of the Colorado potato beetle (fig. 52) feed on the potato plants. After passing the winter in the ground, the beetles appear about the time the potatoes come up, lay their eggs on the under sides of the leaves, and begin feeding. They often destroy the plants in the garden if prompt treatment is not given. The beetles sometimes feed also on eggplants and tomatoes. There are from one to three broods a year.

Treatment.—Paris green is a good remedy. Hand-pick the beetles when they first appear.

BLISTER BEETLES

Blister beetles, which rank next to the Colorado potato beetle as potato pests, have been described on page 6.

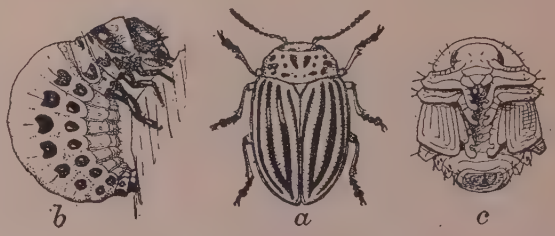

FIGURE 52.—Colorado potato beetle; *a*, Beetle; *b*, larva or "slug"; *c*, pupa (approximately three times natural size).

FLEA BEETLES

Small round holes in the leaves of potato and various related crops, such as tomato and eggplant, show the presence of flea beetles. (See also p. 6 and the warning regarding poisonous residues on p. 47.)

SWEETPOTATOES

STEM ROT

Stem rot occurs nearly everywhere sweetpotatoes are grown. It is due to a fungus which enters and grows in the water vessels, causing a yellowing and wilting of the plants and reduction in the yield. The stems of such plants are black inside, and the sweetpotatoes show a black ring (fig. 53). If such roots are used for bedding next season, they will produce diseased plants.

FIGURE 53.—Section showing stem rot in sweetpotato and in sprouts.

Prevention.—The home gardener in buying sweetpotato plants should make sure that they are healthy and have clean, white roots and stems, and should plant them on land not in sweetpotatoes the year previous. Those who grow plants for large fields should secure Farmers' Bulletin 1059, Sweetpotato Diseases, which gives directions for growing healthy plants.

BLACK ROT

Black rot is a widespread fungus disease, causing roundish, black, sunken spots of varying size on the sweetpotatoes and black cankers on the stems or underground parts (fig. 54). The disease overwinters in diseased roots and readily attacks the slips in the plant bed. Black rot spreads freely in storage, and affected sweetpotatoes have a bitter taste when cooked.

Prevention.—The same as for stem rot.

FIGURE 54.—Sweetpotato and slip, showing black rot.

SWEETPOTATO WEEVIL

In some parts of the Gulf States sweetpotatoes are often attacked by a small antlike beetle with a bluish-green head and abdomen and red legs and thorax (fig. 55). This pest is about one-fourth inch long and comes from a whitish larva, or grub, slightly larger in size, which, by tunneling through sweetpotato tubers, renders them unfit for food. Several broods may be produced each year. Although this weevil works in the field, it continues its injuries in the storehouse.

Prevention.—Carefully sort all sweetpotatoes, throwing aside or using immediately those showing the work of the weevil. Use only uninfested tubers for the slip bed. Carefully clean out and burn all old vines and remnants from last year's crop. Plant the new field as far from the old one as possible.

TOMATOES

FUSARIUM WILT

The widespread and serious tomato disease known as fusarium wilt is caused by a fungus that enters the roots from infested soil, grows into the water vessels, and produces an upward rolling of the leaves, followed by gradual yellowing, wilting, and death of affected plants (fig. 56). The fungus which causes the disease lives in the soil and is also carried in the seed.

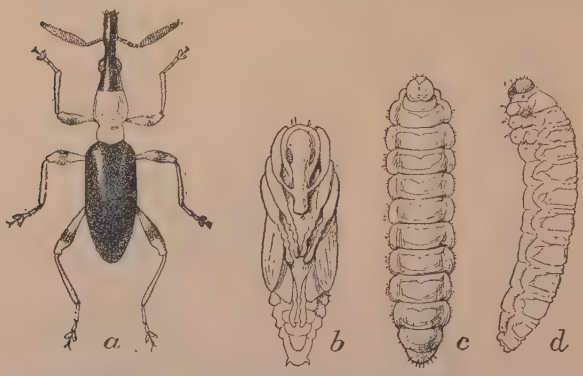

FIGURE 55.—The sweetpotato weevil: *a*, Beetle; *b*, pupa; *c*, larva, view of back; *d*, larva, side view (approximately five times natural size).

Prevention. — Use wilt-free seed and wilt-free soil for growing plants, disinfecting the soil if necessary. If the home garden has become infested with wilt, plant only wilt-resistant varieties. Several excellent varieties of wilt-resistant tomatoes, namely, Marglobe, Pritchard, Break O'Day, and Glovel, have been developed by the United States Department of Agriculture and are now listed by seedsmen. Where only a single variety is to be grown, Marglobe has the widest adaptation. Break O'Day, Pritchard, and Glovel are all earlier than Marglobe in the order named. Break O'Day has open foliage, which makes it subject to sunburn in hot climates, and, therefore, it is best adapted to cooler regions and early season use. Glovel, a pink-fruited variety, was developed in cooperation with the Florida Agricultural Experiment Station as a shipping sort. Pritchard is a second-early, and Marglobe is a midseason sort.

FIGURE 56.—A tomato plant affected with fusarium wilt (late stage). Note the dead leaves with stems and the almost total absence of fruit.

LEAF SPOT

Leaf spot is caused by a fungus which attacks the leaves and stems of the tomato, producing small circular spots with light centers and dark margins (fig. 57). It starts on the lower leaves and progresses upward, causing them to curl, dry up, and fall off, leaving the stems bare except at the tips. This defoliation results in a reduced yield and poor quality of fruit.

Treatment.—Spray thoroughly with bordeaux mixture (p. 45), beginning as soon as the plants are set out and repeat the treatment every 10 days.

Prevention.—Set out only healthy plants. Rotate crops, and plow under old diseased tomato vines in the fall.

FIGURE 57.—Leaf spot on tomato leaves.

BLOSSOM-END ROT

Blossom-end rot is a nonparasitic disease (fig. 58) that causes a decay of the blossom end of green and ripe fruits. The disease usually makes its appearance during or after periods of drought when water is in great demand, due to the rapid development of the fruit.

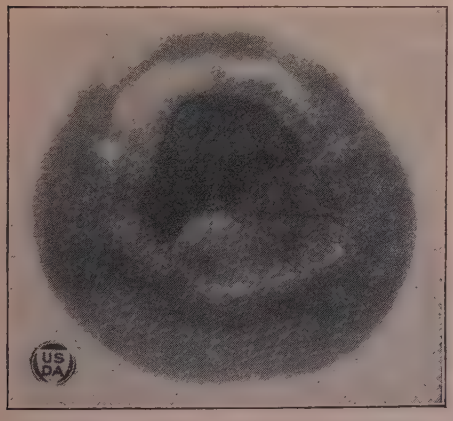

FIGURE 58.—A tomato affected with blossom-end rot.

Treatment.—Loss from the disease can be materially reduced, but not entirely prevented, by avoiding heavy applications of nitrogen, especially manure, and by supplying extra superphosphates.

Prevention.—The disease is likely to develop on plants that have grown for a long period under favorable temperature and soil-moisture conditions and are later exposed to high temperatures and drought. Improving the moisture-holding capacity of the soil will help to reduce the injury from blossom-end rot.

TOMATO WORMS, OR HORNWORMS

Certain large green caterpillars called tomato worms or tobacco hornworms feed on both tomato and tobacco plants. There are two

different species, of very similar appearance, one of which is shown in figure 59. They are the young of large hummingbird moths. In spite of the wicked-looking horn on the tail, they are entirely harmless to people. A large hornworm can strip a tomato plant in 2 or 3 nights, leaving only the stems. There are two broods a season. The gardener should be on the lookout for the first as well as the second brood.

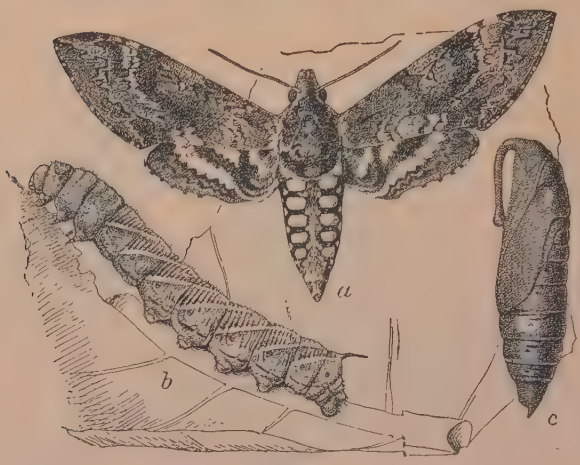

FIGURE 59.—Tomato hornworm: *a*, Moth; *b*, hornworm; *c*, chrysalis (about one-half natural size).

Treatment.—Hand-picking is the best remedy. Sharp eyes are needed to see the worms when they are not moving, since they are the same color as the stems on which they rest during the day. They may often be discovered by their voidings, which will be found beneath the plant on which the worms are feeding. When feeding, they are more readily seen and can easily be killed.

Enemies.—Tomato hornworms will often be found carrying many small white objects on their backs. These are not the eggs of the caterpillar, as many believe. The caterpillar is incapable of laying eggs. The white objects are the cases or cocoons from which come small parasitic insects that prey entirely upon the hornworms and are one of the most effective natural controls for these pests. Do not destroy the hornworms bearing these cocoons, as killing the parasites prevents the continuation of their good work, particularly since the caterpillars do no feeding after the parasites begin to come out.

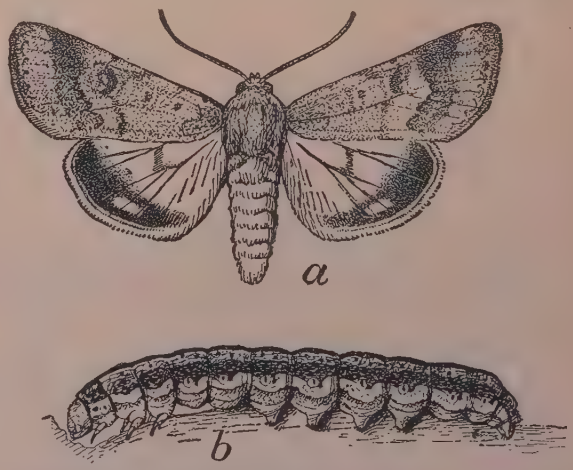

FIGURE 60.—Tomato fruitworm: *a*, Moth; *b*, full-grown fruitworm (approximately twice natural size).

TOMATO FRUITWORM

The tomato fruitworm (fig. 60), also called the corn-ear worm, causes tomato growers much trouble, as it eats into the ripening fruit and destroys it.

Treatment.—Calcium arsenate or paris green applied two or three times will keep the insect partially under control. Applications may be made until the first fruits are about half grown.

See the warning regarding poisonous residues on page 47.

FLEA BEETLES

The potato flea beetle frequently attacks tomatoes and does much damage.

Treatment.—Dip the young plants in a mixture made up of 3 ounces of calcium arsenate and 1 gallon of water before setting them out. Spraying the plants with bordeaux mixture will drive the beetles away.

FUNGICIDES AND INSECTICIDES

Fungicides are materials used to kill bacteria and fungi that cause plant diseases.

Insecticides are materials used to kill insects that attack plants.

FUNGICIDES

BORDEAUX MIXTURE

Bordeaux mixture is the best spray mixture for controlling leaf diseases of garden plants, the potato leafhopper on both beans and potatoes, and as a deterrent against flea beetle attack. It is very important that gardeners realize that this mixture is a preventive and not a cure and that consequently it must be applied before or as soon as the very first signs of injury are seen. A 4–4–50 mixture is used on most crops, but where this strength injures the leaves, a 2–4–50 mixture is recommended. Bordeaux mixture can be purchased in convenient packages from seed dealers, or a better spray can be made more cheaply at home as follows:

Bluestone (copper sulphate)	4 pounds	or	4 ounces.
Quicklime (stone lime)	4 pounds		4 ounces.
or hydrated lime	6 pounds		6 ounces.
Water	50 gallons		3 gallons.

Dissolve the bluestone in a wooden or earthenware vessel, using hot water. Dilute with half the water. Slake the lime in a small quantity of water; then add the rest of the water. Pour the diluted bluestone and lime solutions together, straining them through a fine cheesecloth or brass-wire strainer, and mix thoroughly. The mixture should be made fresh each time it is used, as it does not keep well.

Since stone lime air-slakes rapidly and is then no longer good for bordeaux mixture and also is often difficult to get at short notice, it is best to make up a stock solution of lime containing 1 pound to each gallon of water. This will keep indefinitely if not allowed to dry out. A stock solution of bluestone can also be made by dissolving 1 pound of the copper sulphate crystals in a gallon of water. One quart of each of these stock solutions is equivalent to the 4 ounces of lime and bluestone given in the formula. The stock solutions may be stored in old glass jars or other containers until needed. Dilute each with half the required quantity of water before mixing. Where biting insects, such as potato beetles, are to be controlled, as well as diseases, add 2 ounces of powdered calcium arsenate to the 3-gallon formula for bordeaux mixture given above. For a 2–4–50 mixture use 2 pounds of copper sulphate or 2 gallons of the stock solution for each 50 gallons.

Certain manufactured products, both pastes and powders, are available for making up bordeaux mixture and are especially convenient for use in small gardens and quite satisfactory under most conditions of moderate infection.

BORDEAUX DUSTS AND PASTES

Several bordeaux-dust mixtures for the control of plant diseases are also on the market. They have the advantage of being more quickly and easily applied than sprays, and they do away with the necessity of carrying water long distances for spraying. Under conditions of moderate infection fairly satisfactory results have been secured, but in severe outbreaks of diseases that progress rapidly more complete control has been obtained by thorough and timely spraying with home-made bordeaux mixture.

MERCURIC CHLORIDE

Mercuric chloride (corrosive sublimate) is commonly used for treating seed potatoes and cucumber and cabbage seed for disease control. It is most conveniently purchased at drug stores or agricultural supply houses in the form of tablets, 30 of which cost about 25 cents. For the purposes for which its use is here advised, a 1 to 1,000 solution is used. This is made by dissolving two large tablets in a quart of water. For larger quantities use at the rate of 1 ounce to 8 gallons of water.

To free seed potatoes from scab and black scurf soak them for half an hour in the mercuric-chloride solution. Treat cucumber seed for 5 minutes, stirring frequently, and then rinse thoroughly in running water, to help control angular leaf spot and anthracnose.

Soak cabbage seed 30 minutes and then rinse in clean water.

While this substance is of particular value in treating seeds against disease, it is also applied to plants against the root maggots that attack cabbages, radishes, and similar crops at the dilution given under the heading "Treatment," on page 20. Pour the mixture around the bases of the plants as soon as they are set out, or, in the case of radishes and other row crops, along the rows with a watering can.

Since mercuric chloride is a deadly poison, great care must be taken to keep it out of the reach of children and farm animals, and no seed or tubers treated in it should be fed to any animals or human beings. Only wooden, glass, or earthenware vessels should be used in making the solution or treating the seed or plants, because mercuric chloride attacks metals.

ORGANIC MERCURIES

During the past few years several organic mercury compounds have been put on the market under a variety of trade names and have been used with more or less success for the disinfection of all sorts of seeds and soil in coldframes to control various damping-off fungi or other disease-producing organisms that overwinter in the soil or on the seed. These disinfectants can usually be purchased from the handlers of farm supplies or at drug stores. They are available in both dust and liquid form and should be used in accordance with the directions on the containers.

DUST SEED TREATMENTS

Two dust seed treatments for the prevention of damping-off have been found to give excellent results: (1) Monohydrate copper sulphate dust and (2) red oxide of copper dust. The monohydrate copper sulphate is applied to the seed at the rate of 1 heaping tablespoonful of dust to 0.5 pound of seed. The dust and seed are shaken together in a closed container until the seed is thoroughly coated with the dust. The red oxide of copper is applied in the same manner at the following rates: For tomato seed, 1 tablespoonful to 3.5 ounces of seed; for other small seeds use 1 level teaspoonful of dust to 1 pound of seed.

INSECTICIDES

Two classes of insecticides are used for controlling insects—stomach poisons and contact poisons.

Stomach poisons, such as calcium arsenate, cryolite, and paris green, are used for insects like the striped cucumber beetles, bean beetles, and potato beetles, which injure plants by chewing the leaves or stems.

Contact poisons, such as pyrethrum, soap, and nicotine sulphate, that kill by touching the insects, are necessary for sucking insects like plant lice and squash bugs. Stomach poisons are of no value for sucking insects.

POISONOUS RESIDUES FROM SPRAYS

Sprays or dusts containing arsenicals or other poisonous chemicals of a stable nature, including the fluosilicates, should not be applied to the crop when foliage or fruits that will be marketed or eaten are on the plant, unless the residues can be removed by washing or stripping.

All of these poisonous materials should be applied as sparingly as is consistent with the control of the insects. In the case of dusting, every effort should be made to secure a light, even coating and to avoid excess application, such as frequently results from sprinkling the poison on the plant from a perforated can or sack. Early applications will frequently make it unnecessary to apply control measures late in the development of the plant.

ARSENICALS

Lead arsenate, since it contains two poisons, lead and arsenic, is not recommended as a spray for leafy vegetables and should never be used on those portions of garden vegetables intended to be eaten. Other arsenicals, such as paris green and calcium arsenate, are recom-

For small gardens use a teaspoonful of nicotine sulphate [7] in a gallon of water. A 1-inch cube of hard soap should be shaved up and thoroughly mixed with the solution. Full directions for mixing are given on the containers. For large aphids, like the pea aphid, a little more nicotine sulphate than stated above should be used. By looking carefully at the freshly sprayed plants, one can tell whether there is enough soap in the mixture. If the spray draws together in drops, more soap should be added. When possible fish-oil soap should be used, but cheap laundry soap will do. If the nicotine-sulphate solution has stood for any length of time, it should be mixed thoroughly before being used. The insects themselves must be wet by the spray or they will not be killed. Therefore, the spraying should be very thorough and should be done as soon as the insects are noticed.

NICOTINE SULPHATE AS A DUST

Nicotine sulphate combined with a dry carrier is also useful whenever it is preferable to use this form of application; it can be obtained commercially from several manufacturers. For home use it may be prepared by adding the required proportion of nicotine sulphate to hydrated lime.

For the treatment of small plantings, 1 or 2 pounds of nicotine dust may be prepared by using an ordinary household flour sifter, using 1 pound of hydrated lime and 1 ounce of nicotine sulphate. Be sure that all lumps are broken up and passed through the sifter, and resift at least three times to insure a thorough mixture. Larger quantities may be prepared by placing the lime and nicotine in a keg or metal drum, together with several sizable stones or pebbles, and then rolling the drum for 4 or 5 minutes to secure thorough mixing. This mixture, prepared according to directions, is a satisfactory dust for use against aphids and the striped cucumber beetle. For the latter, the ground around the plants, as well as the plants themselves, should be thoroughly whitened with the dust when the insects make their first appearance. A single application is usually successful, but the treatment may be repeated as often as required.

Nicotine dust must be preserved in tight metal or glass containers, as it loses its strength very rapidly when exposed to the air.

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[7] A solution containing 40 percent of nicotine by weight.

FLOWERS OF SULPHUR

Flowers of sulphur is used to apply broadcast on land that is infested with potato scab to increase the acidity of the soil and thus reduce the damage from scab. To control the red spider and some other kinds of mites, sulphur may be either dusted on plants or mixed with water, a teaspoonful of sulphur to a quart of water, and sprayed.

Under some conditions, particularly during hot weather, sulphur may cause serious injury to the foliage of squashes, melons, and cucumbers and to the fruits of raspberry.

SOAP SPRAYS

Ordinary soapsuds is a good spray for plant lice and leafhoppers. It should be made by dissolving a 1-inch cube of laundry soap or a rounded tablespoonful of whale-oil or fish-oil soap in a quart of hot water. This also must reach the bodies of the insects in order to kill them. This spray must not be used full strength on very tender plants, such as young cabbage or cauliflower in seedbeds, on garden peas, or on young beans, as it will injure the leaves. Use half strength for these plants.

A stock solution of soft soap may be more convenient for quick or frequent applications, and may be made either from bar soap or soap flakes. The weight of actual soap contained should be taken into consideration in using such a mixture. The white coconut-oil soaps are particularly good as insecticides and will work well in hard water.

PYRETHRUM POWDERS AND EXTRACTS

The insect powders sold as buhach, Persian insect powder, and Dalmatian insect powder are composed of the finely pulverized flower heads of three species of *Chrysanthemum*. The active poison that they contain is a volatile oil that is much more poisonous to insects than to the higher animals. This oil forms the basis for a large number of commercial fly and household sprays and has recently been placed on the market as a contact insecticide for use against garden and greenhouse insects. It has the advantage of being practically nonpoisonous to human beings in the dilutions used against insects, and may safely be applied to such crops as greens, snap beans, cabbage, and celery. Either the pyrethrum powder itself or the extracts made from it may be used. They should be kept in tight containers while stored, as they lose strength rapidly by exposure to the air. In applying them they must actually touch the bodies of the insects against which they are used. Follow the directions of the manufacturer as to the application, as the concentration of the commercial preparations varies greatly.

DERRIS AND OTHER ROTENONE INSECTICIDES

Derris and other insecticides containing rotenone are very effective in killing certain insects attacking vegetables, particularly the Mexican bean beetle, the cabbageworm, the melon worm, the pickleworm, and several species of flea beetles. From the evidence at hand, the

compounds containing rotenone, when applied at the dosages recommended in this bulletin, should not leave harmful residues on the crop when harvested, and they may be applied safely to all vegetable crops without fear of injury to the plants. The active principles of these rotenone-containing compounds are rendered inert within a comparatively short time after they are applied to the plants through the action of sunlight and exposure to the air, especially when spread thinly over the plants.

The rotenone content in the commercially prepared dusts and sprays varies. The dusts are sold under various trade names and should be used according to the directions of the manufacturer.

Home-made derris dusts.—Very efficient home-made derris dusts may be prepared by mixing finely ground derris root with various diluents. The derris-root powder should be of such a degree of fineness that not less than 90 percent of it will pass through a sieve having 200 meshes per linear inch, and all of the material (100 percent) should pass through a sieve having 80 meshes to the linear inch. Satisfactory diluents for the derris-root powder are such nonalkaline materials as finely ground tobacco dust, finely ground clay, kaolin, talc, wheat flour, dusting gypsum, diatomaceous earth, infusorial earth, and sulphur. The same method of mixing as described for nicotine sulphate as a dust should be followed, except that lime should *not* be used for this purpose.

The rotenone content of the finished dust mixture depends on the quantity of diluent used and the rotenone content of the derris-root powder.

To prepare a dust containing 1 percent rotenone, use the following ing formula:

Derris powder (4 percent rotenone)	25 pounds (1 part by weight)
Diluent	75 pounds (3 parts by weight)

To prepare a dust containing 0.5 percent rotenone, use the following formula:

Derris powder (4 percent rotenone)	12½ pounds (1 part by weight)
Diluent	87½ pounds (7 parts by weight)

If the rotenone content of the derris powder is greater or less than 4 percent, the proportions of the inert diluent must be varied accordingly. For example: 1 part of a derris powder containing 5 percent of rotenone should be mixed with 4 parts of the diluent by weight—that is, 20 pounds of derris powder and 80 pounds of the diluent—to obtain a 1-percent rotenone dust. Manufacturers of derris-root powders will usually supply ground root of a specified rotenone content upon request.

Home-made derris sprays.—In preparing derris sprays for the control of the Mexican bean beetle, cabbageworms, or similar insects use 2 or 2½ pounds of the derris powder having a rotenone content of 4 percent in 50 gallons of water (or at the rate of 2 or 2½ ounces in 3 gallons of water for smaller quantities). This gives the spray a rotenone content of approximately 0.02 or 0.025 percent.

Table 1 gives the quantities of insecticides or ingredients that should be used with 1, 3, or 50 gallons of water in making up a spray.

TABLE 1.—*Quantities of insecticides or ingredients to be used in preparing sprays*

Materials	With 1 gallon of water	With 3 gallons of water	With 50 gallons of water
DERRIS-ROOT POWDER [1]			
5-percent rotenone	1 ounce [2]	2 ounces	2 pounds.
4-percent rotenone	1 ounce	2½ ounces	2⅔ pounds.
3-percent rotenone	1½ ounces	3¼ ounces	3½ pounds.
0.75-percent rotenone	4½ ounces	13½ ounces	14 pounds.
0.5-percent rotenone	7 ounces	1¼ pounds	21 pounds.
CRYOLITE			
Cryolite	1 ounce [2]	3 ounces	3 pounds.
PARIS GREEN-LIME MIXTURE			
Paris green	2 level teaspoonfuls	6 level teaspoonfuls	½ pound
Lime	2 level tablespoonfuls	2 ounces	2 pounds.
CALCIUM ARSENATE-LIME MIXTURE			
Calcium arsenate	10 level teaspoonfuls	2 ounces	2 pounds.
Lime	10 level tablespoonfuls	8 ounces	8 pounds.
NICOTINE SULPHATE-SOAP MIXTURE			
Nicotine sulphate [3]	1 level teaspoonful	3 level teaspoonfuls	6 fluid ounces.
Cake soap	1-inch cube	4 ounces	4 pounds.
(Or soap flakes)	2 level tablespoonfuls	2 ounces	2 pounds.

[1] These dilutions give a rotenone content of approximately 0.025 percent in the completed spray.
[2] See p. 52 for dry-measure equivalent.
[3] A solution containing 40 percent of nicotine by weight.

The derris powder should be wet thoroughly in a small quantity of water before it is added to the bulk of the water in the spray tank. The results to date indicate that no sticker or spreader is necessary when derris-root powder in water is used on beans. Under some conditions, however, it may be found necessary to add to the spray a nonalkaline spreader or sticker, such as high-grade liquid or powdered neutral coconut-oil soap, miscible pine oil, or one of the sulphonated oils.

FLUORINE INSECTICIDES

There are on the market a number of insecticides, such as sodium fluosilicate and cryolite, in which the poisonous principle is some compound of fluorine. These insecticides are especially useful in the control of the Mexican bean beetle, cabbageworms, and the flea beetle. As has been stated, these preparations should not be applied to the crop when the foliage or fruits that will be marketed or eaten are on the plant, unless the residue can be removed by washing or stripping.

See the warning regarding poisonous residues on page 47.

TABLES OF MEASURES

The following tables of measures will be found convenient for ascertaining the exact quantities of the various materials when used in small sprayers:

Liquid measure:
- 3 level teaspoonfuls=1 level tablespoonful.
- 2 level tablespoonfuls=1 ounce.
- 29 cubic centimeters=1 ounce.
- 16 ounces=1 pint.
- 8 pints=1 gallon.
- 2½ teaspoonfuls in 1 gallon=approximately 1–400 dilution.
- 1½ teaspoonfuls in 1 gallon=approximately 1–800 dilution.

Dry measure (approximately):
- 28.35 grams=1 ounce.
- 16 ounces=1 pound.
- 3 level teaspoonfuls=1 level tablespoonful.
- 4½ level tablespoonfuls of derris-root powder weigh 1 ounce.
- 3 level tablespoonfuls of cryolite weigh 1 ounce.
- 1½ level tablespoonfuls of paris green weigh 1 ounce.
- 4½ level tablespoonfuls of calcium arsenate weigh 1 ounce.

QUANTITY OF SPRAYS OR DUSTS TO APPLY

Sprays.—For small gardens, approximately 2 quarts of liquid spray is required for 50 feet of row for each application. One acre of crops grown in rows (such as beans, potatoes, and cabbage) requires from 75 to 200 gallons of liquid spray per application, depending on various factors, including the crop, the size of the plants, and the thickness of the stand. On an average approximately 100 gallons of spray is required per acre.

Dusts.—For small gardens, approximately 2 ounces of dust mixtures (see tables of measures above) is required per 50 feet of row for each application. One acre requires from 15 to 25 pounds of dust per application, subject to the same variation mentioned for sprays. On an average approximately 20 pounds of the dust mixture is applied per acre at each application.

WHERE INSECTICIDES MAY BE PURCHASED

Information regarding the purchase of the insecticide materials mentioned in this bulletin may be obtained through local dealers in agricultural supplies, seedsmen, general stores, and department stores, or through the county agricultural agents, State agricultural experiment stations, or State departments of agriculture.

HOW TO SPRAY

To be successful in the control of diseases and insects the spray mixtures must be properly made, and spraying must be done promptly and thoroughly. Do not wait until the plants have been seriously injured, but begin to spray as soon as the trouble is seen. Use good apparatus and spray carefully. Using a watering pot or whisk broom is not spraying and is a hit-or-miss method that covers the plants only partially. The ideal spray is a fine mist, and the best work is done when the entire plant is thoroughly and evenly covered with very fine

drops. Stop spraying before the foliage is drenched. The higher the pressure the better the spray.

Spraying with bordeaux mixture should be done before rains rather than after, provided the spray has time to dry on the leaves. The intervals between spray applications should depend on the weather and the rapidity of plant growth. If it is rainy or muggy and there are fogs or heavy dews, these conditions are favorable for diseases and for rapid growth, and spraying should be done more frequently to keep the foliage protected at all times. If the weather is dry, longer intervals may be allowed between sprays.

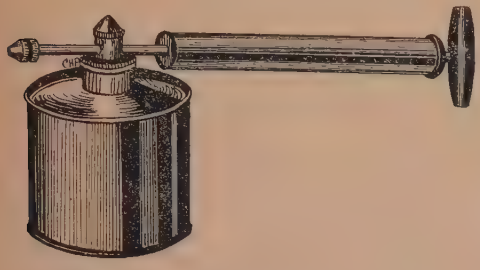

FIGURE 61.—An atomizer suitable for use in a small garden.

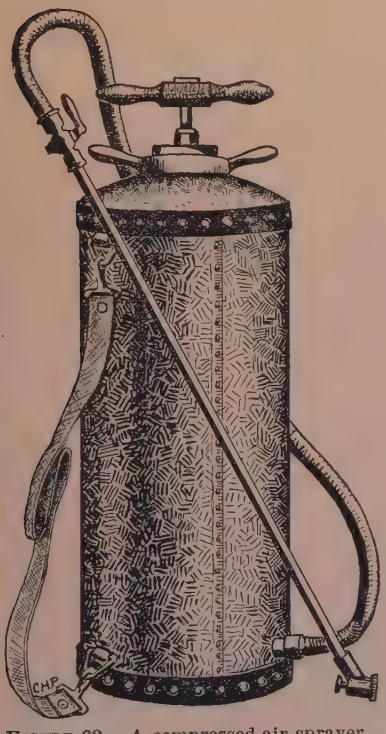

FIGURE 62.—A compressed-air sprayer for use in a small garden.

FIGURE 63.—Type of nozzle to be used on hand sprayers to spray the under sides of the leaves.

SPRAYING AND DUSTING TOOLS

The sprays and dusts described may be put on in many ways. For the small garden an atomizer sprayer (fig. 61) is good, but a compressed-air sprayer (fig. 62) is better for gardens of medium size.

When the treatment requires that the insecticide be applied to the under sides of the leaves, as for the Mexican bean beetle, an angle nozzle should be used (fig. 63).

The container for the liquid in the sprayers should be made of glass, brass, or galvanized steel, as bordeaux mixture and other materials corrode tin and iron.

Shaking the dust from a fine cheesecloth bag or from a can with a handle and a perforated bottom are not recommended, as they frequently result in an uneven and excessive application of material.

FIGURE 64.—A powder gun to use in applying dust mixtures in a small garden.

Several small, cheap, but effective dust guns are on the market (fig. 64) and should be used in preference to the cruder methods.

MISCELLANEOUS CONTROL METHODS

SOIL DISINFECTION

Young plants grown in flats or boxes, to be set in the garden, are often troubled with damping-off (p. 2), and young cabbage plants are likely to be attacked by clubroot (p. 14). The organisms that cause these diseases live in the soil and will be carried on the diseased plants into the garden. The best way to get rid of these organisms is to treat the soil a few days before planting the seeds, either with boiling water or formaldehyde solution or with steam.

If the first method is used, set the flat or box of soil over the sink and pour the boiling water into it as fast as the soil will take it up. Use 9 quarts of water for a box 1 foot square with soil 4 inches deep. When the soil has dried out enough, plant the seeds. In treated soil seeds will sprout better and plants grow faster and stronger than in untreated soil.

For directions for using formaldehyde solution see under Formaldehyde (p. 46).

The pressure cookers or steam sterilizers used for canning purposes are excellent for sterilizing small quantities of soil to kill insects and diseases, or the soil may be thoroughly baked in a pan in the oven.

LIME

Lime is used in several forms in plant-disease control. Quicklime or stone lime in lump form is used for slaking to make bordeaux mixture. When the lime becomes air-slaked from long standing it is of no value for this purpose. A good grade of hydrated lime is also suitable. About 25 percent more by weight than of quicklime is required.

To correct too great acidity in land it is best to apply air-slaked or hydrated lime. Ground limestone is also used. Its action is slower, and it may be applied in larger quantities without injuring the soil. For the control of cabbage clubroot apply hydrated lime at the rate of 25 pounds to the square rod. Do not apply lime to land to be planted in potatoes, since it will tend to increase scab injury.

Air-slaked lime will also keep away certain insects and is a good remedy for slugs.

FUMIGATION

The materials most commonly used for the fumigation of weevil-infested peas, beans, cowpeas, and similar seeds are carbon disulphide,

or hydrocyanic acid gas, or an ethylene oxide–carbon dioxide mixture. (See caution, pp. 55, 56.)

Do not fumigate the seeds until they are thoroughly dry. Place the seeds to be fumigated in an airtight container, such as a tin pail, wash boiler, or watertight barrel, garbage can, barrel lined with heavy paper, or a specially constructed fumigation chamber or room. Fumigated seed should be thoroughly aired as soon as the fumigation period is over.

CARBON DISULPHIDE

Carbon disulphide is one of the most effective, the cheapest, and the simplest fumigant to be considered, wherever insurance or other regulations permit its use. The principal objection is that it is highly inflammable. Under average conditions of fumigation 10 pounds (1 gallon) of the material should be used per 1,000 cubic feet, or for small containers it should be used at the rate of 1 fluid ounce (2 level tablespoonfuls) to each 10 cubic feet. In estimating the quantity of carbon disulphide needed, the number of cubic feet in the container should always be measured and not solely the space occupied by the seed. It is better to use too much than too little of the carbon disulphide.

Pour the liquid carbon disulphide into pie tins or similar shallow dishes and place these on top of the seed to be fumigated, or the liquid may be poured or sprinkled directly upon the seed without danger of injury to germination or bad effects upon the food value. The gas from this fumigant is heavier than air and evaporates more quickly if a large surface of the liquid is exposed to the air.

Fumigation with carbon disulphide must be continued from 24 to 48 hours at or above a temperature of 75° F. It is not effective at temperatures below 65° F.

Caution.—Although carbon disulphide is a standard fumigant and has been used safely for many years with the observance of proper safeguards, *it must be remembered that the gas is explosive and inflammable if exposed to fire. Lighted matches, cigars, pipes, or lanterns, or sparks from electric fixtures, or even very hot steam pipes or radiators will cause it to explode.*

HYDROCYANIC ACID GAS

Fumigation with hydrocyanic acid gas is recommended when large quantities of peas, beans, or similar seed are found infested by weevils in warehouses, seed houses, freight cars, and similar situations. For best results the seeds should be in sacks and so stacked that the gas can reach a large portion of the outside of each sack. Under these circumstances fumigation with the gas has been found very effective in killing weevils.

Hydrocyanic acid gas is extremely poisonous, in fact, fatal, to human beings if breathed even in small quantities. Consequently, it should be used as a fumigant only by skilled, responsible persons who are thoroughly informed upon the subject of fumigation.

The advantages of this fumigant are that it is noninflammable and nonexplosive when mixed with air in the proportions used in fumigation and it does not injure the germination or food value of the seed. As hydrocyanic acid gas acts more quickly than any other known

fumigant, it often proves effective in warehouses, freight cars, etc., that are not entirely airtight, because the gas performs its killing action before escaping through cracks or other openings. Under these or similar circumstances particular precautions should be observed to keep people and domestic animals from coming in contact with the escaping gas.

For general fumigation work one-half pound of liquid hydrocyanic acid or 1 pound of granular sodium cyanide should be used for each 1,000 cubic feet of space. For large warehouses or similar structures well filled with peas or other seeds the dosage should be increased to 20 ounces of liquid hydrocyanic acid, or 2½ pounds of granular sodium cyanide, per 1,000 cubic feet.

There are several methods of generating hydrocyanic acid gas for fumigation purposes. For further information on this subject write to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, or to your county agricultural agent, State agricultural experiment station, or State department of agriculture.

ETHYLENE OXIDE–CARBON DIOXIDE MIXTURE

The ethylene oxide-carbon dioxide mixture is composed of one part of ethylene oxide and nine parts of carbon dioxide by weight. It is a noninflammable, nonexplosive gas and is not highly toxic to man. For these reasons this fumigant may often be used where insurance regulations or other restrictions prevent the use of other fumigants. The gas is sold in cylinders under pressure and is adapted chiefly for use in fumigating chambers. Moreover, it has the advantage of not leaving any appreciable odor in the fumigated product.

The ethylene oxide–carbon dioxide mixture should be used at the rate of 20 pounds per 1,000 cubic feet under average conditions, with suitable changes in this dosage according to the airtightness of the fumigating chamber. The length of fumigation should be the same as for carbon disulphide, and the room should be at a temperature not lower than 60° F.

The cost of this fumigant ranges from approximately 15 to 20 cents a pound delivered.

Caution.—The ethylene oxide-carbon dioxide mixture should not be used to fumigate peas, beans, or other seeds intended for planting purposes, since this gas ordinarily injures the germination of such seed.

HEAT TREATMENT

Most of the common species of weevils in peas, beans, cowpeas, and similar seed can be killed by heat. Such seed should be thoroughly dried before treatment. Small quantities can be treated by placing the seed in an oven, after they have been spread thinly in shallow pans, and heating them to a temperature between 130° and 140° F. for 30 minutes. If the seeds are intended for planting, the temperature should not exceed 135°. Small quantities of weevil-infested seeds can be treated by dipping them into boiling water for 1 minute. If this treatment is continued for more than 1 minute, however, the seeds may be injured for planting purposes. Dry the seeds immediately after removal from the water by spreading them out thinly in a well-ventilated place.

Weevil development in large quantities of beans, peas, cowpeas, and similar seeds can be stopped by a process known as kiln-drying. For further information on this subject write to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, or to your county agricultural agent, State department of agriculture, or State agricultural experiment station.

BENEFICIAL INSECTS

LADYBIRD BEETLES

There is a widespread belief that the small red ladybird beetles, shown together with the younger stages in figure 65, are the parents of injurious plant lice, on account of their abundant association with these pests during the growing season. This is not true, as the ladybird beetle is one of the most effective natural enemies of aphids. A well-grown or adult ladybird requires 50 to 80 plant lice for its daily meal. The beetles should therefore be encouraged as far as possible, as they are among the grower's best friends. They also eat the eggs of many injurious insects.

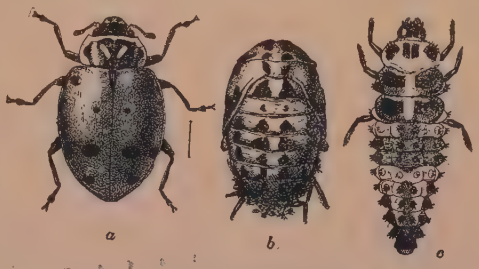

FIGURE 65.—A ladybird: *a*, Beetle; *b*, pupa; *c*, young. These beetles and their young eat dozens of plant lice each day (approximately five times natural size).

SYRPHUS FLIES

Other curious insects often associated with plant lice are green sluglike maggots, often marked with whitish stripes and about one-half inch long. These are the young of small yellow black-banded flies (fig. 66) that may be found about "lousy" plants and are known as "syrphus flies." They should be protected, as they are among the most energetic enemies of plant lice.

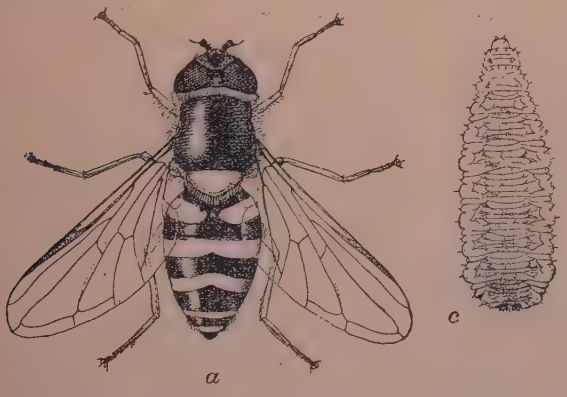

FIGURE 66.—A syrphus fly: *a*, Fly; *c*, *maggot*. This fly helps to control plant lice. It is about the size of a common housefly (approximately six times natural size).

Many other insects, among which are ground beetles, lace-wing flies, and tachina flies, are of benefit to the grower, who should learn to recognize them.

As a matter of fact, were not the efficiency of parasites, predacious insects, and other natural enemies so great, our crops might be a complete loss because of the attacks of plant-feeding insects, which would soon increase to such a point that no vegetables would be left.